

MONTHLY NOTICES
OF THE
ROYAL ASTRONOMICAL SOCIETY.

VOL. LXXXVII. FEBRUARY II, 1927.

No. 4

ANNUAL GENERAL MEETING.

Dr. J. H. JEANS, PRESIDENT, in the Chair.

The Minutes of the preceding Annual General Meeting were read and confirmed.

The Annual Report of the Council was partly read.

The President delivered an address on the award of the Gold Medal to Professor Frank Schlesinger, to whom the Medal had been awarded for his work on Stellar Parallax and Astronomical Photography.

The President having appointed the Scrutineers, the Society proceeded to the ballot for Officers and Council for the ensuing year. The names of those elected are given on p. 348.

The Report of the Auditors of the Treasurer's accounts for the year 1926 was read, and is given on p. 243. The Treasurer's reply to some of the points raised in the Report is given on p. 244.

The thanks of the Meeting were given to the retiring Members of Council, and also to the Auditors of the Treasurer's accounts and to the Scrutineers of the ballot.

Instructor Lieut.-Commander Cecil William Baldwin, M.A., R.N.,
H.M.S. Repulse ;
 Robert Ballard, M.R.C.S., L.R.C.P., Milverton, Market Harborough ;
 Bernhard Richard Baumgardt, 626 West 30th Street, Los Angeles,
 California, U.S.A. ;
 George Edward Kevin Blythe, 110 King Edward's Road, Swansea ;
 Henri Brändli, Royal Irrigation Department, Bangkok, Siam ;
 Alfred John Gould, Wh.Sc., B.Sc., A.M.I.N.A., Assistant Professor
 of Engineering in the University of Rangoon, Prome Court,
 Rangoon, Burmah ;
 Malvalli Gundappa Krishna Murti, A.C.G.I., F.G.S., M.R.San.I.,
 City and Guilds Engineering College, South Kensington, London,
 S.W. 7 ;
 John Ellis Owen, Llysfa, Abersoch, Carnarvonshire ;
 William Harold Robb, 84 McIlwraith Street, Prince's Hill, Melbourne,
 Victoria, Australia ;
 Richard Alfred Rossiter, 23 Milner Road, Bloemfontein, O.F.S.,
 South Africa ;
 Gregory A. Shajn, Pulkovo Observatory (Southern Branch), Simeis,
 Crimea, Russia ;
 Kwanji Suda, Imperial Marine Observatory, Kobe, Japan ;
 Rev. Francis Anthony Tondorf, S.J., Georgetown University, Seis-
 mological Observatory, West Washington, D.C., U.S.A. ; and
 Fleming Voltelin Van der Byl, F.R.G.S., F.R.Met.Soc., Bilton
 Grange School, near Rugby,

were balloted for and duly elected Fellows of the Society.

The following candidates were proposed for election as Fellows of the Society, the names of the proposers from personal knowledge being appended :—

John Alexander Armstrong, 5 King's Road, Monkseaton, Northum-
 berland (proposed by Sir Howard Grubb) ;
 James Ruthven Brown, Ravenslea, Aytoun Road, Glasgow (proposed
 by H. B. Goodwin) ;
 Andrew Fraser, M.I.E.E., 21 Esmond Road, Bedford Park, London,
 W. 4 (proposed by W. H. Steavenson) ;
 William Grant Oliver, L.D.S., Wadham House, Dorchester, Dorset
 (proposed by M. A. Ainslie) ;
 Harold W. P. Richards, B.Sc., Belmore, King Edward Road, New
 Barnet, Herts (proposed by L. N. G. Filon) ;
 David Israel Slutzkin, A.R.C.S., D.I.C., 2 Exeter Road, London,
 N.W. 6 (proposed by Herbert Dingle) ; and
 Albert Charles Stevenson, B.Sc., 19 Willow Avenue, Willowbank,
 Uxbridge, Middlesex (proposed by L. N. G. Filon).

REPORT OF THE COUNCIL TO THE HUNDRED AND SEVENTH ANNUAL
GENERAL MEETING OF THE SOCIETY.*Progress and Present State of the Society.*

	Patron	Institutional Members	Honorary Member	Fellows		Associates	Total
				Compounders	Annual Subscribers		
1925 December 31	1	1	1	225 *	645 *	49	922
Since elected	...	+ 1	...	+ 4	+ 55	...	...
Deceased	...	...	...	- 5	- 13	- 1	...
Resigned	...	...	...	...	- 11	...	...
Since compounded	...	...	...	+ 1	- 1	...	...
Removed from list	...	...	...	...	- 8	...	...
1926 December 31	1	2	1	225	667	48	944

(Four Associates are also Fellows, and are therefore counted twice
in the above table.)

* These figures appeared last year as 227 and 644 respectively. The totals in this table are usually deduced by applying the changes during the current year to the totals of the previous year. This year, however, they were rigorously checked from the List of Fellows. This led to the detection of two errors which had been continued for at least seven years, and which are now removed.

RECEIVED.

	£	s.	d.	£	s.	d.
Received on account of Dividends:—						
£1,250 Metropolitan 3-per-cent. Stock (Tax free) ...	37	10	0			
£2,000 Swansea Corporation 3½-per-cent. Stock (Tax free) ...	70	0	0			
£2,287, 6s. 9d. East Indian Railway 3-per-cent. Debenture Stock ...	54	17	10			
£5,125 London, Midland and Scottish Railway 4-per-cent. Debenture Stock ...	164	0	0			
£750 London, Midland and Scottish Railway 4-per-cent. Consolidated Preference Stock ...	24	0	0			
£2,400 Gas Light & Coke Co. 3-per-cent. Debenture Stock ...	57	12	0			
£2,000 Commercial Gas Co. 3-per-cent. Debenture Stock ...	48	0	0			
£3,852, 12s. 6d. War Loan Inscribed 5-per-cent. Stock (Tax free) ...	192	12	6			
Interest on Deposit Account (proportion) ...	11	19	1			
				660	11	5
Sale of Publications:—						
Monthly Notices, Memoirs, Geoph. Suppl., etc.:—						
At Society's Rooms ...	£67	17	0			
At Wheldon & Wesley's ...	271	4	10			
				339	1	10
Herschel Papers ...				2	0	0
Reprints ...	87	16	3			
Miscellaneous Receipts:—						
Sale of Photographs ...	75	8	0	428	18	1
Postages, etc., repaid ...	8	18	9			
London Mathematical Society, contribution to expenses of Meetings, etc. ...	30	0	0			
Use of Telephone ...	0	6	10			
Assistant Secretary and Clerk, Pension Premiums ...	19	5	0			
Sale of Waste Paper ...	2	7	6			
				136	6	1
Trust Fund Dividends:—				1225	15	7
£1,212, 13s. 3d. East Indian Railway 3-per-cent. Debenture Stock ...	29	2	2			
£542, 18s. 2d. India 3½-per-cent. Stock (Tax free) ...	19	0	0			
£946, 6s. 11d. 5-per-cent. War Stock, 1929/47 (Tax free) ...	47	6	4			
£988, 3s. 3d., ditto (Lectureship Fund) (half-year's interest) (Tax free) ...	24	14	1			
Special Fund:—				120	2	7
Donations in 1926 ...	16	11	7			
Interest on National War Bonds ...	50	0	0			
Interest on £419, 17s. 11d. Conversion Loan 4½-per-cent. Stock ...	15	2	4			
Interest on Deposit Account (proportion) ...	1	7	8			
Received on account of Subscriptions:—				83	1	7
520 Annual Contributions for 1926 (including 2 Institutional Membership fees) ...	1092	0	0			
9½ Annual Contributions for 1927, paid in advance ...	19	19	0			
59 Admission Fees (including 4 due in 1925) ...	123	18	0			
55 First Contributions (including 4 due in 1925) ...	98	14	0			
Arrears paid off:—						
5 for 1923 ...	£10	10	0			
20 for 1924 ...	42	0	0			
68 for 1925 ...	142	16	0			
				195	6	0
Compositions ...				1529	17	0
Gift for Endowment of Annual Lectureship ...				157	10	0
				1000	0	0
Balances, 1926 January 1:—						
Cheques outstanding ...	6	6	0			
In hand of Assistant Secretary on Petty Cash Account ...	13	16	2			
At Bankers', on Current Account, as per Pass Book ...	170	15	0			
At Bankers', on Deposit Account (including Special Fund, £10, 10s. 9d.) ...	291	3	0			
At Bankers', on "C" Account (Trust Funds) ...	138	17	7			
				620	17	9

Examined and found correct.

(Signed) FRANK ROBBINS.
L. J. COMRIE.

£4737 4 6

Astronomical Society, from 1926 January 1 to December 31.

PAID.

	£	s.	d.	£	s.	d.
Assistant Secretary : Salary	225	0	0			
Assistant Secretary : Special Grant for Library Catalogue	10	0	0			
Clerk : Salary	160	0	0			
Assistant Secretary and Clerk for work for London						
Mathematical Society in 1925	10	0	0			
Pension Premiums for Assistant Secretary and Clerk	57	15	0			
Porter and Wife : Wages	143	15	6			
Health and Unemployment Insurance	18	17	7			
Pensions, J. and Mrs. Barrett, ...	78	0	0			
				703	8	1
Fire and Accident Insurance	15	15	3			
Telephone	12	6	2			
Registration of Telegraphic Address	2	0	0			
Time Signal	5	2	8			
				35	4	1
Postage and Packing (including postage of <i>Monthly Notices</i> , etc., £80, 12s. 1d.)				128	15	1
Printing, etc. :—						
<i>Monthly Notices</i> (9 numbers)	886	2	8			
<i>Geophysical Supplements</i> (2 numbers)	191	8	0			
<i>Memoirs</i> , 64, pt. 2	52	6	9			
Supplementary Library Catalogue	147	0	7			
Reprints	93	4	3			
Miscellaneous	74	0	6			
Photo-engraving	74	14	0			
				1518	16	9
Reproduction of Photographs for sale				82	11	4
Library Equipment	1	5	11			
Royal Society, half share of Profits on Herschel Papers ...	1	0	0			
Stationery and Office Expenses	26	18	8			
Coal, Gas, Electric Light, Firewood	88	1	9			
House Cleaning and Laundry	22	13	1			
Furniture, Fittings, and Repairs	77	9	6			
Subscription to Galileo Memorial	10	0	0			
Typewriter	26	0	0			
Porter's Uniform Overcoat	5	5	0			
Purchase of early volumes of <i>Monthly Notices</i>	2	0	0			
Miscellaneous Expenditure	12	16	3			
Expenses of R.A.S. Meetings	17	10	4			
Expenses of Geophysical Discussions	6	14	3			
Expenses of L.M.S. Meetings	5	6	5			
				303	1	2
Bank Charges and Cheque-Book				1	4	9
				2773	1	3
Purchase of £988, 3s. 3d. 5-per-cent. War Stock 1929/47 (Lectureship Fund)				1000	0	0
Expenditure on Trust Accounts :—						
Turnor and Horrocks Fund } Library	15	9	5			
Harry Watson Fund	98	14	9			
Lee and Janson Fund	10	0	0			
				124	4	2
Balances, 1926 December 31 :—						
In hand of Assistant Secretary on Petty Cash Account	19	5	8			
At Bankers', on Current Account, as per Pass Book	294	14	5			
At Bankers', on Deposit Account (including Special Fund, £93, 12s. 4d.)	391	3	0			
At Bankers', on "C" Account (Trust Funds)	134	16	0			
				839	19	1

REVENUE

	£	s.	d.	£	s.	d.
To General Expenditure as per Cash Account	2773	1	3			
„ Reserve for Accounts due but not presented	218	0	0			
	2991	1	3			
Less Reserve for Accounts due 1925 now written back	265	0	0			
				2726	1	3
„ 30 Annual Contributions in Arrear written off ...	63	0	0			
„ 9 Annual Contributions 1926 written off as per contra	18	18	0			
				81	18	0
Excess of Income over Expenditure, 1926	...	...	...	236	0	3

£3043 19 6

ACCOUNT, 1926.

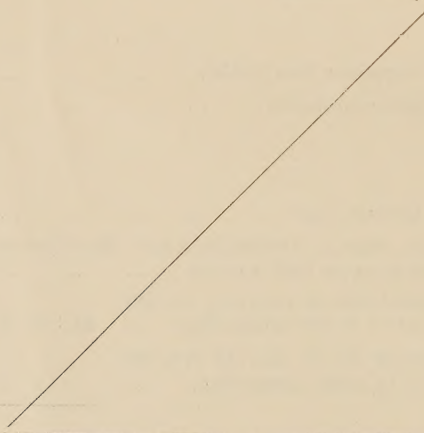
By Subscriptions—		£	s.	d.	£	s.	d.
520	Annual Contributions for 1926 (including 8 from Fellows elected 1926 January, and 2 Institutional Membership Fees)	1092	0	0			
14	ditto, paid in advance in 1924, 1925, and now matured	29	8	0			
101	ditto, outstanding	212	2	0			
9	Contributions for 1926 due, but unpaid, in respect of Fellows died, or names removed, and written off per contra	18	18	0			
644					1352	8	0
39	First Contributions, 1926, at 2 guineas	81	18	0			
12	ditto, at 1 guinea	12	12	0			
4	ditto, outstanding	4	4	0			
55					98	14	0
55	Admission Fees, 1926	115	10	0			
4	ditto, outstanding	8	8	0			
59					123	18	0
4	Composition Fees (initial)	126	0	0			
1	Since compounded	31	10	0			
5					157	10	0
	Sundry Debtors, 1926				42	17	0
	Dividends, Sales of Publications, and Miscellaneous Receipts, as per Cash Account	1225	15	7			
Less	Payments due in 1925 (£57 0 4, less £11 1 0 still outstanding)	£45	19	4			
	Payments due in 1924 (£5 16 9, less £3 15 0 still outstanding)	2	1	9			
		48	1	1			
					1177	14	6
	By Income Tax deducted, 1926				90	18	0
					£3043	19	6

Examined and found correct.

(Signed) FRANK ROBBINS.
L. J. COMRIE.

BALANCE SHEET,

LIABILITIES.

	£	s.	d.	£	s.	d.
9½ Subscriptions 1927, paid in 1926				19	19	0
Sundry Creditors for Accounts due but not presented ...				218	0	0
Cash Balances (Income) due to Trust Funds—						
Turnor and Horrocks Fund	1	1	2			
Harry Watson Fund	22	10	0			
Lee and Janson Fund	26	3	8			
Hannah Jackson Fund	60	7	1			
Lectureship Fund	24	14	1			
				134	16	0
Trust Funds (Capital), as per contra				2,949	17	0
Special Fund—						
As at 1925 December 31	1,483	7	2			
Donations and Interest, 1926	83	1	7			
				1,566	8	9
General Fund—As at 1925 December 31	15,685	16	9			
Add—Excess of Income over Expenditure, 1926 ...	236	0	3			
				15,921	17	0
						
				£20,810	17	9

225 Compounders.

Examined and found correct.

(Signed) FRANK ROBBINS.

L. J. COMRIE.

1927 January 12.

INVESTMENTS.

AS AT 1926 DECEMBER 31.

GENERAL FUND.

£1250 Metropolitan 3-per-cent. Stock.

£2000 Swansea Corporation $3\frac{1}{2}$ -per-cent. Stock.

£2287, 6s. 9d. East Indian Railway 3-per-cent. Debenture Stock.*

£5125 London, Midland, and Scottish Railway 4-per-cent. Debenture Stock.*

£750 London, Midland, and Scottish Railway 4-per cent. Consolidated Preference Stock.*

£2400 Gas Light and Coke Co. 3-per-cent. Debenture Stock.*

£2000 Commercial Gas Co. 3-per-cent. Debenture Stock.*

£3852, 12s. 6d. War Loan Inscribed 5-per-cent. Stock, 1929-47.

GROVE-HILLS SPECIAL FUND.

£500 National War Bonds, 1927.

£500 National War Bonds, 1929.

£419, 17s. 11d. Conversion Loan $4\frac{1}{2}$ -per-cent. Stock, 1940-44.*

FIVE TRUST FUNDS.

£1212, 13s. 3d. East Indian Railway 3-per-cent. Stock.*

£542, 18s. 2d. India $3\frac{1}{2}$ -per-cent. Stock.

£1934, 10s. 2d. War Loan Inscribed 5-per-cent. Stock, 1929-47.

* Taxed at source.

Report of the Auditors for the Year 1926.

We have examined the Treasurer's account of receipts and expenditure, and the revenue account and balance sheet, for the calendar year 1926, and have certified these accounts to be correct.

The balance in hand on 1926 December 31 amounted to £839, 19s. 1d. This figure includes £134, 16s Trust Funds, and £93, 12s. 4d. Special Fund.

The Balance Sheet shows that on 1926 December 31 the amount of the General Fund was £15,921, 17s.

The Revenue Account shows that the income for the year amounted to £3043, 19s. 6d., and the expenditure to £2807, 19s. 3d., giving an excess of income over expenditure equal to £236, 0s. 3d.

The investment holdings have been verified by the Bank of England and the Westminster Bank respectively.

A very heavy burden has been laid on the Society by the granting of an annual pension of £78 to the late porter and his wife, who served the society for eight years only. These pensions are not statutory, but are purely voluntary allowances, which, fortunately, may be modified or even cancelled at the discretion of the Council.

A new Trust Fund has arisen through the generosity of the President, Dr. J. H. Jeans. The sum of £1000 has been invested in War Loan and the first half-year's interest was received on December 1. This fund is to be known as the "George Darwin Lectureship Fund."

The average rate of interest earned by money placed on deposit was £3 per cent., and by the whole investments is £3, 10s. 4d. per cent.

It is a subject for congratulation that no further encroachment has been made on the capital of the Grove-Hills Special Fund.

We regret to report that no repayment of Income Tax has been made for nearly two years. The total amount due to the Society is £151, 14s. 3d. The matter is still *sub judice*, and the outlook very uncertain. Under these circumstances the provision of a reserve seems to be a matter of ordinary prudence.

The question of outstanding debts is one which may perhaps be deemed worthy of the attention of the Council during the coming year.

A list has been placed on the table of the names of those Fellows who are in arrear for sums due at the last Annual General Meeting of the Society, with the amount due against each Fellow's name.

The number of outstanding subscriptions for the year 1926 amounted at the end of the year to 101, or 22 less than at the corresponding date in 1925.

We are indebted to the Assistant Secretary for the facilities that have been placed at our disposal during the Audit.

(Signed) FRANK ROBBINS.
L. J. COMRIE.

The Treasurer made the following statement after the Auditor's report had been received :

The reason that the late porter had retired unfit for further work after eight years' service was mainly that he was engaged during the war period, when only elderly men were available. The Council were faced with the alternative of pensioning him and his wife or of knowingly letting them go into the workhouse. It was safe to say that it was very unlikely that the Council would in future abandon or lower this payment until the pensioners came under the operation of the Old Age Pensions Act.

The remark that the investments earned money at the rate of £3, 10s. 4d. per cent., so far as it had any meaning, referred only to the familiar fact that at a date when many of the Society's investments were made, capital could only derive from stable securities a lower rate of interest than at present. It had no relevance to the accounts of the present year.

The reference to money that might have been drawn by the Council from the Grove-Hills Special Fund, as an encroachment, was unfortunate, if not misleading. The Fund was specially collected by Col. Grove-Hills to meet the immediate financial difficulties of the Society. As a matter of fact, the Council had been able to carry through the difficult years of the immediate past without drawing from it much, and it stood at present as a reserve fund to meet any such contingency as might arise from the recent action of the Income Tax Commissioners.

Gifts to the General Funds of the Society.

The John Lee Gift : In 1836 John Lee, Esq., LL.D., gave the Advowson of the living of Hartwell ; in 1844 he gave the Advowson of the living of Stone, Bucks. In 1879 these Advowsons were repurchased by his heir, Edward Lee, Esq., for £700.

The Lawson Bequest (1856) : Henry Lawson, Esq., bequeathed to the Society the sum of £200, free of legacy duty.

The Carrington Bequest (1876) : R. C. Carrington, Esq., F.R.S., bequeathed to the Society £2000 Consols.

The Lambert Bequest (1877) : C. J. Lambert, Esq., presented to the Society the sum of £500, free of legacy duty, being part of a sum of money bequeathed by his father, Charles Lambert, Esq., for scientific purposes.

The Knott Gift (1899) : Mrs. George Knott presented to the Society the sum of £250, to defray the cost of printing *Memoirs*, vol. lii., containing the late Mr. Knott's Observations of Variable Stars.

The Peek Bequest (1904) : Sir C. E. Peek bequeathed to the Society the sum of £200, as a contribution towards the expense of printing the Rousdon Variable Star Observations (*Memoirs*, vol. lv., part 1).

The McClean Bequest (1905): Frank McClean, Esq., LL.D., F.R.S., bequeathed to the Society the sum of £2000, free of legacy duty.

The Farrar Bequest (1906): The Rev. A. S. Farrar, D.D., bequeathed to the Society the sum of £100, free of legacy duty.

The Brook Gift (1907): C. L. Brook, Esq., gave one-third of the cost of printing Pogson's Variable Star Observations (*Memoirs*, vol. lviii.).

The Gill Bequest (1914): Sir David Gill, K.C.B., F.R.S., bequeathed to the Society the sum of £250, in aid of Astronomical Research, in grateful remembrance of a like sum paid out of the funds of the Society in aid of his expedition to Ascension in the year 1877. In accordance with his wishes this bequest was expended to defray part of the cost of publishing vol. lxiii. of the *Memoirs*, containing the Theory of the Four Great Satellites of Jupiter.

The Parsons Gift (1922): The Hon. Sir Charles Parsons, K.C.B., F.R.S., gave to the Society £2500 War Stock (1929-47), in memory of his father, the 3rd Earl of Rosse, who made the 6-foot Reflector, and who died 1867 October 31.

The Grove-Hills Bequest (1922): Colonel E. H. Grove-Hills, C.M.G., F.R.S., bequeathed to the Society, free of legacy duty, his collection of early Astronomical and Mathematical books up to the year 1700, together with a sum of £250 to cover the expenses incurred by the Society in connection with the books.

The Grove-Hills Special Fund: As already reported to the Society, the late Treasurer, Col. Grove-Hills, collected by his private efforts, with the approval of the Council, a Special Fund to meet the immediate financial difficulties of the Society. He aimed at securing £1800, and up to the present the total amount received from all sources is £1766, 8s. 9d., of which £200 was transferred during 1923 to the General Fund to meet current expenditure, £1072, 16s. 5d. was invested in National War Bonds, and £400 was invested (1925) in Conversion Loan 4½-per-cent. Stock, 1940-44.

	£	s.	d.		£	s.	d.
1926 Jan. 1. Cash Balance				1926 Dec. 31. Cash Balance			
of Fund	10	10	9	of Fund on Deposit	93	12	4
Donations in 1926 ..	16	11	7				
Interest on National							
War Bonds and Con-							
version Loan ..	65	2	4				
Interest on Deposit							
Account	1	7	8				
	<u>£93</u>	<u>12</u>	<u>4</u>		<u>£93</u>	<u>12</u>	<u>4</u>

The following were donors to this Fund in 1926:—

W. Hall.

J. H. Jeans.

Trust Funds.

The Lee and Janson Fund: In 1834 John Lee, Esq., LL.D., gave £100, and in 1876 T. C. Janson, Esq., bequeathed £200, the interest to be given to the widow or orphan of a deceased Fellow. These amounts now stand in £334, 10s. 9d. East Indian Railway 3-per-cent. Debenture Stock.

	£	s.	d.		£	s.	d.
1926 Jan. 1. Balance of				1926. Grant from Fund ..	10	0	0
Fund	28	3	2	1926 Dec. 31. Balance of			
1926. Dividends, East				Fund	26	3	8
Indian Railway ..	8	0	6				
	<u>£36</u>	<u>3</u>	<u>8</u>		<u>£36</u>	<u>3</u>	<u>8</u>

The Turnor Fund and the Horrocks Memorial Fund: In 1853 the Rev. Charles Turnor, M.A., bequeathed a sum of £500, which now stands in £464, 18s. East Indian Railway 3-per-cent. Debenture Stock. In 1876 the Society received a sum of £38, 15s., the unexpended balance of a fund collected for the purpose of erecting a memorial in Westminster Abbey to Jeremiah Horrocks: to this the Society added the sum of £55, 15s., and the whole now stands in £103, 6s. East Indian Railway 3-per-cent. Debenture Stock. The interest on these funds is to be used in the purchase of books for the Library.

	£	s.	d.		£	s.	d.
1926 Jan. 1. Balance of				1926. Purchase of Books ..	15	9	5
Fund	2	17	9	1926 Dec. 31. Balance of			
1926. Dividends, East				Fund	1	1	2
Indian Railway ..	13	12	10				
	<u>£16</u>	<u>10</u>	<u>7</u>		<u>£16</u>	<u>10</u>	<u>7</u>

The Harry Watson Memorial Fund: In 1920 Mrs. Watson presented to the Society the sum of £300 as a memorial to her late husband, Lieut.-Col. Harry James Watson, F.R.A.S., the interest on this sum to be used for the purchase of books for the Library, such books to be indicated by a special book-plate. This gift now stands invested in £542, 18s. 2d. India 3½-per-cent. stock. In 1923 Mrs. Watson bequeathed a further sum of £958, 17s. 0d. to the Society, which now stands invested in £946, 6s. 11d. 5-per-cent. War Stock 1929-47. The Council resolved that these two sums should together constitute a Trust Fund, to be designated *The Harry Watson Memorial Fund*, to be used for the purchase and binding of books.

	£	s.	d.		£	s.	d.
1926 Jan. 1. Balance of				1926. Purchase of Books			
Fund	54	18	5	and Binding	98	14	9
1926. Dividends, India 3½				1926 Dec. 31. Balance of			
per cent.	19	0	0	Fund	22	10	0
Dividends, War Stock							
5 per cent.	47	6	4				
	<u>£121</u>	<u>4</u>	<u>9</u>		<u>£121</u>	<u>4</u>	<u>9</u>

The Hannah Jackson (née Gwilt) Fund: In 1861 Mrs. Hannah Jackson (née Gwilt) gave £300 Consols, which now stands in £309, 18s. 6d. East Indian Railway 3-per-cent. Debenture Stock; the interest to be given in medals or other awards in accordance with the terms of the Trust.

	£	s.	d.		£	s.	d.
1926 Jan. 1. Balance of Fund	52	18	3	1926 Dec. 31. Balance of Fund	60	7	1
1926. Dividends, East Indian Railway ..	7	8	10				
	<u>£60</u>	<u>7</u>	<u>1</u>		<u>£60</u>	<u>7</u>	<u>1</u>

The George Darwin Lectureship Fund: In 1926 June, the President, Dr. J. H. Jeans, presented to the Society the sum of £1000 for the endowment of an annual lectureship, to be called *The George Darwin Lectureship*, the lecture to be on some subject of interest to astronomers, preference being given, in electing a lecturer, to one normally resident outside the British Isles.

This sum has been invested in £988, 3s. 3d. 5-per-cent. War Stock 1929-47, and the income will be annually applied to the purposes of the Trust in accordance with the terms of the Deed of Gift.

	£	s.	d.		£	s.	d.
1926 June. Gift for Endowment of Lectureship	1000	0	0	1926 June 25. Purchase of £988, 3s. 3d. War Stock 5 per cent. 1929-47 ..	1000	0	0
1926 Dec. 1. Dividends, War Stock 5 per cent. (Half-Year's Interest) ..	24	14	1	1926 Dec. 31. Balance of Fund	24	14	1
	<u>£1024</u>	<u>14</u>	<u>1</u>		<u>£1024</u>	<u>14</u>	<u>1</u>

Celestial Photographs.

The following have been added to the list of Celestial Photographs reproduced by the Society for sale to the Fellows:—

R.A.S.
Ref. No.

367. Halley's Comet, 1910 June 2, 30-in. Refl., Exp. 30 m., Helwan.
368. Field of Orion, 10-in. lens, Exp. 2 h., Franklin-Adams Chart.
369. Mars and San José, 1924 Nov. 9 (in violet and infra-red light), Wright, Lick Observatory.
371. Solar Surface, 1885 June 2, Janssen.
372. Great Bolide, 1923 Sept. 12^d 21^h 55^m, Klepesta, Prague.
373. Exploding Andromedid Meteor, 1895 Nov. 23, 2-in. lens, Butler.
374. Solar Eclipse Track, 1715 April 22, Halley.
375. Solar Eclipse Track, 1724 May 11, Halley.
376. Spectroheliogram, Ha, Bright Filaments, 1926 Feb. 22^d 8^h 8^m, Kodaikanal.
377. Spectroheliogram, Ha, Bright Filaments, 1926 Feb. 22^d 8^h 36^m, Kodaikanal.
378. Spectroheliogram, K, Bright Filaments, 1926 Feb. 22^d 9^h 0^m, Kodaikanal.

R.A.S.
Ref. No.

379. Spectroheliogram, Ha, Bright Filaments, 1926 Feb. 22^d 9^h 4^m, Kodaikanal.
 380. Neb. N.G.C. 5247, 1915 March 21, Crossley Refl., Lick Observatory.
 381. Neb. N.G.C. 5921, 1912 June 10, Exp. 3^h, Crossley Refl., Lick Observatory.
 382. Neb. N.G.C. 2903-5, 100-in. Refl., Mount Wilson.
 383. Neb. N.G.C. 4567-8, 60-in. Refl., Mount Wilson.
 384. Neb. N.G.C. 5236, 100-in. Refl., Mount Wilson.
 385. Neb. N.G.C. 5850, 100-in. Refl., Mount Wilson.
 386. Neb. N.G.C. 7479, 60-in. Refl., Mount Wilson.
 387A. Solar Corona, 1926 Jan. 14, 4-in. Refr., Exp. 30^s, Aston, Sumatra.
 387B. Solar Corona, 1926 Jan. 14, 4-in. Refr., Exp. 30^s, Aston, Sumatra.
 388. Chromosphere at Sun's Limb, 1926 Jan. 14, 19 ft. Prismatic Camera, Aston, Sumatra.
 389. Chromosphere at Sun's Limb, 1926 Jan. 14, 19 ft. Prismatic Camera, Aston, Sumatra.
 390. Solar Eclipse Tracks 1715 (observed), 1724 (predicted), Halley.
 391. Solar Eclipse Track, 1927 June 29.

Publications of the Society.

During the past year the Society has published *Monthly Notices*, vol. lxxxvi., *Geophysical Supplements*, Nos. 7 and 8, *Memoirs*, vol. 64, pt. 2, and Supplementary Catalogue of the Library, 1898-1925.

OBITUARY.

The Council regret that they have to record the loss by death of the following Fellows and Associate during the past year :—

Fellows :—Edgar Tarry Adams.
 Thomas Allison.
 *Henry Jamyn Brooks.
 Robert Bryant.
 Maurice Harvey Clarke.
 †Dudley Sydney Ashworth Cosby.
 John Louis Emil Dreyer.
 *William Edgar Geil.
 James William St. Clare Hill.
 Alfred Holness.
 Charles Leigh-Lye.
 William James Lewis.
 Joaquin de Mendizabal-Tamborrel.
 George Morham.
 Harry Krauss Nield.
 Herbert Lovis Noel Noel-Cox.
 William Thow.
 Julien J. Stanislaus Tripplin.
 Associate :—William Joseph Hussey.

EDGAR TARRY ADAMS was born at Kingsland, North London, on 1852 December 8. He was educated at Denmark Hill Grammar School, and received his business training in the City of London Brewery, Upper Thames Street. In 1880 he married Helen, daughter of the late Mr. and Mrs. E. J. Roberts, of 20 Fleet Street, London, E.C., and from that time until his death he resided at The Cottage, Halstead, Essex. All his life Mr. Adams took the keenest interest in nautical matters, and owned several private yachts. His collection of navigational instruments was extensive and probably unique. An article by him on the History and Uses of Navigating Instruments appeared in *The Encyclopædia of Ships and Shipping* in 1908, and was reprinted in the *Dictionary of Scientific Instruments*, published in 1921. He became an Associate of the Institution of Naval Architects in 1897. Mr Adams' interests were many-sided. In 1900 he joined Cambridge University as a Fellow Commoner of Downing College, and studied physics under the Rev. T. C. Fitzpatrick, geology under Professor Hughes, and astronomy under Sir Robert Ball. He was a Fellow of the Royal Meteorological Society and kept daily records of local climatological conditions. In politics he was a staunch conservative, and was one of the earliest members of the Primrose League. In connection with this he formed a branch of the Boys' Naval Brigade, under the auspices of the Navy League. At the outbreak of the War Mr. Adams was appointed Naval Recruiting Officer for Halstead and district, and in 1917 was granted an honorary commission as Lieutenant, R.N.V.R. Although in failing

* Died in 1925, but death not reported till 1926.

† Died in 1924, but death not reported till 1926.

health for some time, he carried on all his duties until within six weeks of his death, which took place on 1926 July 29. He leaves a widow, two sons, and two daughters.

He was elected a Fellow of the Society on 1907 February 8.

THOMAS ALLISON, who died at Wanganui, New Zealand, on 1926 January 9, was born in 1858. He received his early education at the Wanganui Collegiate School and at a private school in Wellington, where he passed the Civil Service examinations. Returning to Wanganui, he worked for a time on his mother's farm at Riverley. He then joined the staff of the Bank of New Zealand; later, he entered the office of the late S. T. Fitzherbert, to whom he was articled for five years. He passed examinations as barrister and solicitor in 1883.

Early in 1884 he went to California, where he took up land and commenced fruit-farming at Fresno. He carried this on with success for three years, and then, in 1887, came back to New Zealand, and bought land at Westmere, where he farmed for some time.

He lost his wife in 1901, and in the June of 1902 he came back to Wanganui and went into practice, which he continued till 1919.

He bore a high reputation in his profession, from which he resigned only from a fine sense of responsibility, because he, at times, found himself subject to slight lapses of memory. He had various hobbies, and was an extremely companionable man. In photography he was quite an expert, and he employed this in his many excursions on the mountains of his native land. He was a member of the Alexandra Cavalry, and volunteered for service under Captain Sommerville in connection with the Te Whiti rising at Parihaka.

He took up the study of astronomy as a young man and, while in the United States, purchased a telescope by Wray. He joined the Wanganui Astronomical Society shortly after its inception, and was, until the last, one of its most active members, being at times President and Secretary. For a period of twenty-two years he acted as Hon. Assistant with Mr. J. T. Ward, the Hon. Director of the Observatory, taking his full share of the demonstration work carried out at the Observatory for the benefit of members and the general public, as well as taking part in the observational work carried on at the Observatory. He accompanied Dr. C. E. Adams, Government Astronomer, to the North Cape, N.Z., in July 1925, to observe the annular eclipse of the Sun. He assisted in the photographic and other work carried out on that occasion.

The optics of astronomy was a subject of considerable interest to him, and he collaborated with Mr. Ward, on several occasions, in the production of silver on glass mirrors for reflecting telescopes.

He was elected a Fellow of the Society on 1920 December 10.

[The Council are indebted for the above particulars to Mr. J. T. Ward.]

DUDLEY SYDNEY ASHWORTH COSBY, only surviving son of the late Colonel Robert A. G. Cosby and Alice Sophia, only daughter of Sir George Edward Pocock, was born on 1862 January 12, and was educated at Eton and in Germany. In 1895 he married Emily Mabel, only child

of the late General J. G. Gubbins, who died in 1918, leaving three sons and two daughters. Captain Cosby was Deputy Lieutenant for Queen's County, Ireland. He served for four years in the Queen's Co. Rifles, and was a captain in the 4th Battalion Scottish Rifles. He served in the Military Intelligence Department during the European War. He was the author of many pamphlets on Irish and social questions.

He was elected a Fellow of the Society on 1921 December 9.

JOHN LOUIS EMIL DREYER was born at Copenhagen on 1852 February 13. He was descended from a well-known family of soldiers. His grandfather was a staff officer in Napoleon's army, under Marshal Davoust. His father, Lieutenant-General John Christopher Dreyer, served with distinction in the Schleswig-Holstein War in 1864, and in after years became Danish Minister of War and Marine.

It may be noted that he was second cousin of Georges Dreyer, the distinguished Professor of Pathology at Oxford, their paternal grandfathers being brothers.

At the age of five Dreyer went to a school at Copenhagen, where he remained for twelve years. He was a studious and industrious boy, and showed great ability in history, mathematics, and physics. In view of his subsequent researches on Tycho Brahe, to which he devoted the later years of his life, it is interesting to note that while at school, at the age of fourteen, he came across a book which described the island of Hven and the Observatories of Tycho Brahe. This fascinated his impressionable mind so forcibly that, as he has himself recorded, he made up his mind then and there "to be an astronomer and nothing else." At this period he made many visits to the Copenhagen Observatory, where his conversations with Schjellerup roused his enthusiasm in his favourite science. It was the influence of Schjellerup's good and sensible advice that tended to mould the boy's mind for accuracy and sound judgment, which have characterised all Dreyer's scientific work.

He has thus recorded his early experience: "In the course of the summer holidays I asked my old friend Professor Borneman if he could help me to get a look at the Observatory. He did not like to bother the Director, Professor d'Arrest, but asked the 'Observer,' Professor Schjellerup, and he showed me the instruments one afternoon. When we were leaving he said he would be glad to help me at any time if I wanted information about anything. I did not hesitate to avail myself of that offer, and during the next three years I used to pay him a visit about once a month and sit for upwards of two hours talking of astronomical matters. My mother used to say that I always came home from these visits wild with enthusiasm."

In 1869 Dreyer entered the University of Copenhagen, and from this year to 1873 he attended lectures, first on logic, then on astronomy and mathematics, including the theory of functions and analytical geometry, differential and integral calculus, and analytical mechanics. He attended the lectures on astronomy of d'Arrest, who had the direction of his astronomical studies. It was a great pleasure to him that in 1870 he was given a key of the Observatory and was thus afforded free access to the instruments. He made a thorough study of the

Pistor and Martins' Transit Circle and determined the graduation errors of the circle. This was of good service to him in after years, when he used a similar instrument at Dunsink by the same makers.

Dreyer's first scientific paper was "On the Orbit of the First Comet of 1870," which was published in the *Astronomische Nachrichten* in 1872. He had been urged by d'Arrest to take up computing, with the result that he started to compute the orbit of this comet, from which he determined the elements and published an ephemeris. Prior to this he had published some popular articles on astronomy, and also a criticism of a book on Tycho Brahe, a subject in which he was always much interested. While working at the Copenhagen Observatory, in the early part of 1874, his attention was specially given to the question of personal errors in observations, on which he wrote an essay in answer to a prize question offered by the Copenhagen University. This essay was considered of such high merit that he was awarded a gold medal. It was at Copenhagen that Dreyer took his Ph.D. degree.

In 1874 Dreyer left Copenhagen and came to Ireland to take the position of Assistant to Lord Rosse at Birr Castle, in place of Dr. Copeland, who had resigned. Here he remained till 1878 August. During this period he published several papers in the Royal Irish Academy and the Royal Society of Dublin. The first notable communication to the Royal Irish Academy was "On Personal Errors in Astronomical Transit Observations." This was an exhaustive history of the subject and a close investigation of the various methods employed in eye and ear as well as chronometric recording.

After Bessel's important discovery of the personal equation, the subject was generally explored at most Observatories, and various instrumental methods were devised by Hartmann, Plantamour and Hirsch, Wolf and Kaiser, to determine the influence of personal errors on observations. All these methods are very fully discussed in this paper, as well as the Greenwich Observations, where the question had received continuous study. Not only did the author discuss personal errors that occur in observing stars and nebulae, but also artificial stars, thus presenting a complete history of the state of this question up to 1876.

While at the Observatory of Birr Castle, Dr. Dreyer made many observations of nebulae and clusters with the 6-foot and 3-foot reflectors, which are incorporated in the General Memoir of Observations made from 1848 to 1878, presented by Lord Rosse to the Royal Dublin Society. This aroused his keen interest in nebulae, to which he devoted so large a portion of his astronomical labours. In 1877 he presented to the Royal Irish Academy an important memoir forming a supplement to Sir John Herschel's General Catalogue of Nebulae and Clusters. This contained 1136 new nebulae discovered by d'Arrest, Marth, Stephan, Tempel, and others, with many corrections to Sir John Herschel's Catalogue, the positions being for the epoch 1860.

In 1878 Dr. Dreyer left Birr Castle on his appointment as Assistant at the Dunsink Observatory occasioned by the resignation of Mr. Burton. Here he was in charge of the Meridian Circle by Pistor and Martins, already referred to, and he was occupied mainly in meridian observations. On 1882 June 12 he left Dunsink on being appointed Director

of the Armagh Observatory in succession to Dr. Robinson, a post he continued to hold till 1916. He at once set to work to reduce the observations which had been made by Dr. Robinson from 1859, with the result that in 1886 he was able to publish the Second Armagh Catalogue of 3300 stars for the epoch 1875. This contained many observations made by him in 1882 and 1883.

In 1886 December Dr. Dreyer submitted to the Council of this Society a second supplementary catalogue of nebulae similar to that referred to above. Considering, however, that Sir John Herschel's work was out of print, and the great inconvenience of using three catalogues and lists of corrections, the Council proposed to him to amalgamate the three catalogues into a New General Catalogue of Nebulae. This suggestion was accepted by Dr. Dreyer, who at once devoted himself to the laborious task of forming from the above materials the present "New General Catalogue of Nebulae and Clusters, being the catalogue of Sir John Herschel, revised, corrected, and enlarged." This most important and useful work was published in 1888 in the *Memoirs* of this Society.

The catalogue contains the places and descriptions of 7840 nebulae for the epoch 1860, being all such objects known up to the end of 1887. Dr. Dreyer subsequently published two Index Catalogues of Nebulae and Clusters. The first consists of 1529 new nebulae found in the years 1888 to 1894, with notes and corrections to the New General Catalogue. The second contains 3857 nebulae and clusters found in the years 1895 to 1907. Both these supplementary catalogues were published in the *Memoirs*, in the years 1895 and 1908 respectively. The great labour involved in the preparation of these catalogues by Dr. Dreyer alone is striking evidence of his untiring energy and devotion, and the work has been recognised throughout the world as the standard catalogue of nebulae.

While engaged on the above work, Dr. Dreyer made a series of micrometric observations of nebulae and adjacent stars, which forms a memoir presented to the Royal Irish Academy in 1893. This gives the resulting positions of 100 nebulae for the epoch 1890, made with the 10-inch refractor of the Armagh Observatory, using a bright line micrometer.

The fascination which the story of Tycho Brahe exercised on the mind of Dr. Dreyer, when a boy at school, must be considered as the germ which developed later into many historical researches of great interest.

There is no scientific subject in which the literature is so extensive as that of astronomy. From the Greeks, the Arabs, and the European philosophers of the Middle Ages, the literature is voluminous. The great monumental work of Delambre is the most prominent example we possess of an attempt to form a comprehensive history of astronomy from the earliest times to the end of the eighteenth century. All other researches have been limited to chapters in the development of astronomy. Dr. Dreyer's learning and rare erudition have made some notable contributions to this history, and by long and patient exploration of numerous less known authors he has elucidated many doubtful points and disposed of many popular errors. He writes: "Astronomers

are so frequently obliged to recur to observations made during former ages for the purpose of supporting the results of the observations of the present day, that there is a special inducement for them to study the historical development of their science." The history of astronomy had from the very first attracted him very strongly, and at Copenhagen he continued to read everything bearing on it, particularly if it had anything to do with Tycho Brahe. Imbued with this view he, in 1890, published a book on the life and work of Tycho Brahe as an attempt to add another link to the chain of works illustrating the birth of modern astronomy.

As might be expected, Dr. Dreyer has spared no labour to present an exhaustive account of the life and observations of this astronomer. For many years he lost no opportunity of collecting materials for this work. Away from libraries at Armagh, his difficulties must have been very great. He records the great assistance he got from consulting the Crawford Library at Edinburgh, so rich in the literature of the period, failing which he could hardly have accomplished the task. Dr. Dreyer's object was not only to narrate in some detail the various incidents in the life of this great astronomer, but also to describe his relations with contemporary men of science, and to review his scientific labours in their connection with those of previous astronomers. The result is a contribution to the history of astronomy in the sixteenth century of permanent and lasting value. He establishes the great advancement in astronomy made by Tycho, which is universally recognised, notwithstanding the caustic remark of Mästlin that "Tycho had hardly left a shadow of what had hitherto been taken for astronomical science, and that only one thing was certain, which was that mankind knew nothing of astronomical matters."

In this connection we may here suitably refer to what may be considered as the *magnum opus* of Dr. Dreyer's astronomical life, namely, the editing of the complete astronomical works and correspondence of Tycho Brahe. This great undertaking had been in his thought for several years. The interest, so early excited in the boy's mind at school, was dominant throughout his life, and culminated in the splendid series of volumes published by the Carlsberg Institute of Copenhagen. Besides the immense labour of editing a work of this magnitude, Dr. Dreyer contributed two lengthy Prolegomena, the first written at Armagh in 1913, and the second at Oxford in 1923, both translated into Latin by Dr. Raeder; and he also added numerous notes to many of the volumes. Twelve handsome volumes have already been published, all of which were presented by him to this Society, and two additional volumes will probably complete the work.

In 1906 Dr. Dreyer published a *History of the Planetary Systems from Thales to Kepler*. He was induced to write this book to dispel some of the legends connected with the history of the cosmical systems so often repeated. He refutes the assertions that Thales knew the earth to be a sphere, that Pythagoras taught the motion of the earth round the sun, that Plato taught the daily rotation of the earth, and many others, though most of these assertions had already been disproved by Sir George Lewis. This work involved a very extensive amount of research,

and, with copious references to authorities, it forms one of the most valuable works we possess on the astronomical systems of the Greeks and the great astronomers, Copernicus, Tycho, and Kepler.

In 1881 Dr. Dreyer, in association with Dr. Copeland, commenced the publication of an International Journal of Astronomy, entitled *Copernicus*. This contained several memoirs of importance, foremost among which was one by Dr. Dreyer on "A New Determination of the Constant of Precession." The material he employed consisted of Lalande's Catalogue in the *Histoire Céleste*, which he reduced to 1800, and the Catalogue of Schjellerup for 1865. This involved the use of many faint stars. Newcomb, in his memoir on the "Precessional Constant," published in 1897, says that Dreyer's investigation is prefaced by a very exhaustive history of previous determinations of this constant, and he testifies the value he attaches to the paper in these words: "I accept the very elaborate discussion of the precessional motion given by Dreyer." No words could form a more fitting tribute to the ability Dreyer had shown in this lengthy investigation.

Three volumes of *Copernicus* were published up to 1884, when, from lack of support, it ceased to exist. This was a misfortune, as this journal afforded a medium for international communications for which no substitute has since been found in this country.

In the year 1910 a joint committee of the Royal Society and the Royal Astronomical Society was formed to prepare a complete edition of Sir William Herschel's works. Dr. Dreyer was a member of this committee and eventually he became the editor, and all the work of collating numerous manuscripts, arranging the papers, and passing the work through the press, was done by him. He contributed an introductory memoir on the life and work of Sir William Herschel, founded almost exclusively on his own unpublished memoranda, journals of observations, and letters. This important work was published in 1912, and to Dr. Dreyer belongs, in great part, the merit of this worthy memorial to William Herschel.

In 1916 the Council of this Society had formed so high an opinion of the merit of Dr. Dreyer's labours in preparing his Catalogue of Nebulæ, and of his contributions to astronomical history, that they awarded him their Gold Medal as the highest honour in their power. In justifying this award, the President described in detail the mass of work contributed to astronomy by the medallist, which has been already in part referred to. Speaking of the medallist's investigation of the Constant of Precession, he emphasised that "such an undertaking requires the highest degree of skill, knowledge, and industry, and I believe that no higher encomium could be passed upon the result than Newcomb's mature and reiterated acceptance of it."

Dr. Dreyer joined this Society in 1875, and for many years he was on the Council. In 1923 he was elected President, which position he held for two years. During this period he delivered two addresses. The first, "On the desirability of publishing a New Edition of Isaac Newton's Collected Works," and the second in presenting the Gold Medal to Professor Eddington.

In the first most interesting address he calls attention to the fact

that the collected works of the great astronomers of the past have in several instances been published, "but the greatest name of all is missing from the list, that of Isaac Newton." He discusses from the historical point of view all the papers and publications of Newton. He refers to the changes and alterations made in subsequent editions of the *Principia*, all these variants being of great importance; and he makes an eloquent appeal to astronomers and mathematicians to remedy the deplorable gap in the scientific literature of this country by publishing a proper and complete edition of his works.

His second address was given in justifying the award of the Medal to Professor Eddington for his researches "On Star Streaming, on the Internal Constitution of a Star, and on General Relativity."

In 1923 was published the *History of the Royal Astronomical Society*, in commemoration of the centenary of the Society. In this work Dr. Dreyer was joint editor with Professor Turner, and he contributed to it a history of the periods 1830 to 1840, and 1880 to 1920.

He contributed over thirty papers to the *Monthly Notices*. His last communication was a lengthy discussion on "The Original Form of the Alfonsine Tables," the result of his examination of all the printed editions of these tables, and of nineteen different Latin codices, mostly at Oxford. In this paper he clears up certain difficulties and puts a new light on some questions.

In addition to his published works, Dr. Dreyer has left five volumes of manuscript notes entitled "*Adversaria ad historiam astronomicam pertinentia*." It was his habit to make extensive notes of the books he read, and these volumes contain extracts and remarks from various books and manuscripts, many of which are little known. The preparation of an index to these notes is contemplated, which will then make them readily available to those engaged in historical research.

So soon as he had lived the statutory time in this country, Dr. Dreyer at once obtained a Certificate of Naturalisation. In 1916 he left Ireland and came to reside in Oxford, where the proximity of the Bodleian Library gave him greater facilities for pursuing his researches. Here he received the honorary degree of M.A., prior to which he had, at Belfast, been awarded the degree of D.Sc.

In epitomising the scientific career of a man so single minded in the purpose of his life as Dr. Dreyer, much that excites our admiration for his learning and erudition must necessarily be passed over. He was gifted with that sound and sufficient knowledge of mathematics which Sir John Herschel defines as the criterion of an astronomer, and this, coupled with his command of classic and modern languages, and an unsparing devotion to achieve the best possible result, were the means which enabled him to enrich astronomy in so many ways.

Dr. Dreyer was endeared to his many friends by his gentle and amiable disposition, and his loss is greatly mourned by all astronomers and by all who knew him. At the latter part of 1925 his health showed signs of breaking down, and shortly after it became apparent that recovery could hardly be hoped for. He had never really recovered from the loss of his wife in 1923, and this no doubt contributed much to his condition. For many months he bore his illness with patience and

cheerfulness, still able to give his thoughts to some reading and research, and even to correcting proofs. He peacefully passed away at Oxford on 1926 September 14, at the age of seventy-four.

In 1875 he married the daughter of Mr. John Tuthill of Kilmore, Co. Limerick, and he leaves one daughter and three sons, all of whom are living. His daughter married Mr. Warham Shaw-Hamilton of Darton, Co. Armagh. His eldest son is Colonel John Dreyer, C.B., D.S.O.; the second, Rear-Admiral Frederic Dreyer, C.B., C.B.E., who commanded the flagship H.M.S. *Iron Duke* in the Battle of Jutland; and the third, Major George Dreyer of the Royal Artillery.

He was elected a Fellow of this Society 1875 March 12.

E. B. K.

WILLIAM EDGAR GEIL, who was born at Doylestown, Pa., on 1865 October 1, spent most of his life in exploration and lecturing, and was the author of several books on China. He was much interested in astronomy, and made many observations in expeditions to China and Africa. In 1912 he married L. Constance Emerson, a kinswoman of Ralph Waldo Emerson. Dr. Geil was returning home from a visit to the Holy Land, where material for a new book had been obtained, when he was taken ill with influenza at Venice, and died after three weeks' illness. His body was brought home to Doylestown by his widow.

He was elected a Fellow of the Society on 1906 January 12.

THE REV. J. W. ST. CLARE HILL was closely associated during the greater part of his life with work among the blind. After graduating at Cambridge in 1886 he took Holy Orders and served for a short time in a London parish, but from 1892 to the time of his death he was Principal of the Royal School for the Blind, which was transferred from Southwark to Leatherhead several years ago. The marked success of this institution was very largely due to his great ability and devoted work. He was also officially connected with the S. London Institute, and took a leading part in the formation of the College of Teachers of the Blind, and was for many years Chairman of the Board of Examiners. In 1903 he was appointed by the Board of Education Government Consulting Expert on the teaching and training of the Blind.

He combined a kindly and lovable disposition with great firmness and strength of character—qualities which made him peculiarly fitted for the work to which he devoted his life. In spite of his many activities in connection with his profession he found time for other interests, and amongst them was astronomy. He did not, however, undertake any actual work in this field.

He was elected a Fellow of the Society on 1925 May 8.

ALFRED HOLNESS was born in 1846 at Faversham, Kent, where his father was a market gardener. Quite early in his life he went up to London and was employed in the firm of Mr. W. H. Broom, a publisher of religious works. A few years later he decided to commence on the same lines for himself, and for fifty-three years he was engaged on this work, retiring from the City in 1919. He published during his long business life a large number of evangelical periodicals and pamphlets,

and was the editor of *The Springing Well*. He also took part in evangelical work in lodging-houses, public halls, and theatres.

Owing to his numerous occupations, he was unable to do any practical work in astronomy, but he took a lifelong interest in the science, and was a regular attendant at the Society's meetings.

After retiring from business he visited his sons in Canada and South Africa, and whilst in Durban he was delighted at being allowed to observe with the telescope at the Observatory.

His outlook on life was a world-wide one, and he was a Fellow of the Royal Geographical Society.

He married in 1871, and died on 1926 October 8, leaving a widow, two sons, and two daughters.

He was elected a Fellow of the Society on 1918 January 11.

CHARLES LEIGH-LYE was born on 1861 January 27, in India, where his father was Archdeacon of Bombay for many years. He was educated at Haileybury School (where he was accounted one of the most brilliant scholars) and at Sandhurst. In 1918 he married Ida Lilian Ashworth. During the war he commanded the Depot of the York and Lancaster Regiment. He then went to the Ministry of Pensions, where he acted as "Officer's Friend," and endeared himself alike to officers and staff by his sympathy, thoroughness, and knowledge. In 1922 he was obliged to give up this work owing to ill-health. He had a lifelong passion for mathematics and astronomy, but his military duties greatly interfered with his exercise of these studies. His tastes were more especially on the side of pure mathematics, and he spent much time studying the properties of transcendental curves, such as the curve of pursuit. Colonel Leigh-Lye died on 1926 December 12 at Haywards House, Sea View, Isle of Wight, after a long illness, leaving a widow.

He was elected a Fellow of the Society on 1904 June 10.

WILLIAM JAMES LEWIS, the second son of the Rev. John Lewis, was born at Llanwyddelan, in Montgomeryshire, on 1847 January 16. He was educated at Llanrwst Grammar School and Jesus College, Oxford, where he gained the Senior Mathematical Scholarship in 1871, and was elected a Fellow of Oriel College in 1872. In 1875 he became an assistant in the Mineralogical Department of the British Museum, but retired from this position, in 1877, on account of his health. He took the opportunity to travel, and joined two solar eclipse expeditions, making observations on the polarisation of the corona. In 1881 Mr Lewis was appointed Professor of Mineralogy at Cambridge, in succession to Professor W. H. Miller, and he held this Chair until his death, which took place on 1926 April 16. He was elected a Fellow of the Royal Society in 1909, and was a Fellow of the Crystallogological Society from its foundation in 1876. He was the author of several important books and papers on crystallography and mineralogy.

He was elected a Fellow of the Society on 1873 February 14.

JOAQUIN DE MENDIZÁBAL-TAMBORREL was born at Puebla on 1852 March 29. After a brilliant career at school and college he moved, in 1874, to Mexico City, where he entered the Military College

of Chapultepec with the intention of pursuing the career of a military engineer; later, however, he entered the National School of Engineers, and qualified as a geographical engineer. From 1878 to 1883 he worked as topographer with the International Commission for delimiting the boundary between the republics of Mexico and Guatemala. On the termination of this Commission, Señor Mendizábal was appointed Assistant Astronomer at Tacubaya Observatory, which post he held for two years. He then for a short time became a Professor of Mathematics, and later on occupied the chairs of Astronomy and Geodesy at the Military College of Chapultepec, which he held until 1891. During this time he paid frequent visits to Europe to represent his country at various scientific congresses. In 1891 he was appointed Assistant Chief Engineer on the Boundary Commission of Guatemala, and he was occupied with this work for five years. Señor Mendizábal was the author of many works of a mathematical nature, chief of which is his *Tables of Eight-figure Logarithms*, with trigonometric functions to ten figures—a work which occupies 1250 folio pages. He was an enthusiastic advocate of the decimal division of the circle and of time. He was a member of many European and American mathematical and astronomical societies. He died in Mexico City on 1926 September 8.

He was elected a Fellow of the Society on 1920 June 11.

GEORGE MORHAM was born at Edinburgh on 1845 November 26, and lived there throughout his life. His interest in astronomy was started by his seeing Donati's comet when he was thirteen. In 1865 he studied the elements of the subject under Professor P. G. Tait at the University of Edinburgh, and throughout his life kept up his interest in astronomy by reading and by the use of his telescope, a 3½-in. equatorial, by Cooke. In 1905 August he went to Burgos to observe the total solar eclipse of that year, and he had arranged to go to Riga in 1914 August, but the outbreak of War prevented his doing so.

He was by profession an engineer and quantity surveyor, and was engaged on the erection of a number of large buildings in Scotland. In 1892 he assisted in the building of the Royal Observatory on Blackford Hill.

He married in 1877 September, and died on 1926 November 8, leaving a widow and family.

He was elected a Fellow of the Society on 1921 February 11.

HARRY KRAUSS NIELD, of The Old College, Barnet, Herts, died on 1926 October 23, after a few days' illness. He was prospective Liberal candidate for the Macclesfield Division of Cheshire, which he unsuccessfully fought at the last election, and was previously Liberal candidate for the St. Albans' Parliamentary Division. An architect by profession, he was Deputy Chief of the Building Licensing Department of the Ministry of Munitions during the War. He was a Fellow of the Royal Geographical Society. Only a few weeks before his death Mr Nield returned from America, where he married Miss Margery Porritt, daughter of Mr. Edward Porritt, a historical and political writer, of Connecticut.

He was elected a Fellow of the Society on 1902 January 10.

HERBERT LOVIS NOEL NOEL-COX was born in 1860, the son of the Hon. and Mrs. H. E. Cox (of Jamaica), and was educated on the Continent and at Rugby School. He worked as a tutor and then qualified as a solicitor. Later he joined St. Thomas's Hospital and qualified in Medicine at Durham University, of which he became a Life Governor. He travelled a good deal and his interests were very wide and included psychical research, philately, music, and photography. From 1915 to 1919 he held War Office appointments at Epsom and Belmont Military Hospitals as an anæsthetist, and afterwards was medical officer at Hanwell Asylum. He was at one time medical officer to the Church Lads Brigade, and when quite young took a deep interest in the Ragged School Union, and did some years of self-denying work at Field Lane. After a long period of ill-health and considerable pain, during which he did not cease to keep pace with every new movement and invention, he died on 1926 December 6.

He married in 1898, and leaves a widow, son and daughter.

He was elected a Fellow of the Society on 1897 May 14.

JULIEN STANISLOUS TRIPPLIN, who died on 1926 August 24, was born at Besançon on 1843 May 7. He came of an old Polish family, and was the son of a military surgeon who migrated to France. Julien Tripplin always had a mechanical bent, and when he came to England he entered the horological industry in the workshops of J. W. Benson, in Bond Street. Starting on his own account at No. 1 Holborn Circus, he ultimately became the London representative of Messrs. Rotherham & Son, with whom he remained until his retirement in 1913. In collaboration with Mr. Edward Rigg he translated the standard work *Saunier's Treatise on Modern Horology*. He was a British Juror at the Inventions Exhibition, 1885, and at the 1889 and 1900 Exhibitions in Paris, for which services he was nominated Officier d'Académie and Chevalier de la Légion d'Honneur. He was a Liveryman of the Clockmakers Company, a Vice-President of the British Horological Institute, and one of the founders of the British Watchmakers' Guild. He was a great lover of music, and played the 'cello, but in his later years increasing blindness and deafness deprived him of this pleasure. He died childless, but leaves a widow.

He was elected a Fellow of the Society on 1886 January 8.

WILLIAM JOSEPH HUSSEY, son of John Milton Hussey, was born near Mendon, Ohio, on 1862 August 10. He entered the Engineering School of the University of Michigan in 1882, but two years later his studies were interrupted by lack of funds. For three years he acted as a teacher in Illinois, and in vacation periods joined a party of railroad surveyors, in which his neatness and accuracy earned him promotion to clerical work. In 1887 he was able to return to Ann Arbor, where he took the degree of B.S. (Engineering) in 1889, after a brilliant career as a student.

For a short while he was an assistant in the office of the *American Ephemeris and Nautical Almanac*, under the late Simon Newcomb. Then he returned to Ann Arbor to spend the two years 1889-1891 as an instructor in mathematics. At this time Professor Harrington,

who had succeeded Watson as Director of the Detroit Observatory of the University of Michigan, was called to Washington as the first Chief of the Weather Bureau, and during 1891-2 Hussey was acting Director, until the appointment of Professor Asaph Hall, Junr. It was during these years that his first publications appeared. His *Logarithms and Other Mathematical Tables* have remained to this day the best 5-figure tables published in America. He was joint author with Professor Harrington of a translation of Dziobek's *Mathematical Theories of Planetary Motions*.

The next four years, from 1892-6, were spent as Professor of Astronomy in the Leland Stanford Junior University, at Palo Alto, California. During this period he was a frequent visitor to the Lick Observatory as a volunteer observer, and in 1896 we find him appointed Astronomer in that institution. His early work at Mount Hamilton consisted chiefly of observations and orbit determinations of comets and satellites, and includes an excellent series of photographs of Comet Rordame, with a study of its physical characteristics. The high standard of his work was soon recognised by his fellow-astronomers.

About this time Hussey commenced the work on which his chief claim to fame rests—his observations and discoveries of close double stars. In the years 1898-9 he reobserved all the double stars discovered at Pulkowa by Otto Struve, making at least three observations of each star. His assiduity is evidenced by the fact that, with the assistance of a recorder, 1920 observations were made in the course of a year, the record for one night being 80. He collected all previously published observations of these stars, a work which, together with his own observations, forms vol. v. of the *Publications of the Lick Observatory* (1901), a model presentation of double star observations, and an excellent forerunner to Burnham's classic *General Catalogue* (1906). His description of the methods of observing will repay study by any observer; it reflects the trained engineering mind combined with the observational temperament.

Hussey's interest in the field of micrometrical work was now fairly established. Since the days of the younger Struve there had been no systematic search for double stars, although many had been discovered by Hough, Burnham, and others. He therefore planned in conjunction with his colleague, Professor R. G. Aitken, a systematic examination of all stars down to the ninth magnitude north of -22° . The two astronomers divided the sky between themselves in such a way that each became responsible for about half the area involved. Up to the time of his departure from Mount Hamilton in 1905 Hussey had discovered and measured 1327 close double stars, an achievement for which he was awarded the Lalande Gold Medal of the Paris Academy of Sciences in 1906.

In 1905 October Hussey returned to Ann Arbor as Professor of Astronomy in the University of Michigan, and Director of the Detroit Observatory. Here his activities were devoted principally to teaching, construction, organisation and administration. As a teacher his courses were mainly on dynamical and spherical astronomy, involving the reading of Watson, Moulton, and Chauvenet. The traditions of the

University of Michigan, which numbers among its graduates more well-known astronomers than any other American university can boast of, have been well maintained, for to-day it ranks as one of the most important teaching centres of astronomy.

In his new surroundings Professor Hussey soon found scope for his engineering skill. The University appropriated sums totalling £5000 for the construction of a large reflecting telescope of $37\frac{1}{2}$ -inch aperture, which was designed by Hussey, and constructed, with the exception only of a few parts beyond the capacity of the tools available, in the University and Observatory workshops. His own interests did not tend towards the astrophysical side, and his generosity in allowing this instrument to be devoted to the spectroscopic programme initiated by his colleague, Professor R. H. Curtiss, is but one example of that unselfishness which characterised his dealings with associates and students alike.

The programme of construction included buildings and workshops, as well as instruments. More recently, when the encroachment of railways and buildings made the present site untenable, he chose a country location, to which the observatory will eventually be transferred. Before his death he had established a Student's Astronomical Laboratory, equipped with two refractors and a transit instrument.

In 1911 Hussey's organising ability was sought by another institution. The National University of La Plata was at that time well equipped with elaborate buildings and excellent instruments erected during the prosperity enjoyed by Argentina in the last two decades of the nineteenth century. Lean years had followed, and then a period of reconstruction, in which the need of an organiser was felt. It was arranged that Professor Hussey should become Director of La Plata, while still retaining his directorship at Ann Arbor, dividing his time equally between the two institutions. Under his constructive direction the southern observatory was soon in working order. Instrument shops were erected and equipped. Regular zone observations were begun with the Gautier Meridian Circle on stars south of -52° ; two catalogues have already appeared, two more are in press, and the observations for a fifth have begun. The 17-inch refractor has been used for the observation of comets and for the discovery and measurement of double stars, and Hussey himself with its aid increased his total of double star discoveries to 1650. The work with the comet-seeker led to the detection on its first return of the 61-year period comet of Westphal, and to the discovery of Comet Delavan in 1913. In all Hussey made four trips to Argentina, before resigning his directorship in 1917.

Hussey's greatest ambition was to establish an observatory in the southern hemisphere for the discovery and observation of double stars. In this he was warmly supported by Mr. R. P. Lamont, of Chicago (now President of the American Steel Foundries), with whom he had shared rooms as a student. Mr. Lamont was prepared to finance the construction of a 24-inch refractor, so designs and detailed drawings for the mounting were commenced at Ann Arbor in 1910. Although the order for the optical parts was placed in 1911 both French and German glass manufacturers failed to produce the necessary discs before the

entry of the United States into the War in 1917. It was not until 1923 that two 27-inch discs were obtained from Jena. They were entrusted to J. B. McDowell, successor to John A. Brashear, and were nearly completed at the time of his tragic death in November of that year. A year later the completed lens was delivered by Hageman, and the telescope, whose mechanical parts and driving clock had been made in the Observatory workshops, was set up in Ann Arbor, where its performance proved to be entirely satisfactory.

Meanwhile Professor Hussey had journeyed to South Africa in 1923, and selected a site for the telescope near Bloemfontein. Difficulty in placing a contract for the 56-foot dome required had to be met and solved. An attack of pleurisy delayed departure for a week, but in 1926 October, accompanied by Mrs. Hussey and Dr. R. A. Rossiter, he landed in London, *en route* for South Africa to realise the dream of half a lifetime. He visited the Nautical Almanac Office and the Royal Observatory, and on October 27 addressed the meeting of the British Astronomical Association for a few minutes. On the following evening, while dining with friends, he died suddenly as the result of a ruptured aneurism. It is gratifying to know that his University and Mr. Lamont have decided that the Expedition is to proceed—a truly fitting memorial to one of the most distinguished astronomers of our age.

Hussey was a recognised expert on the selection of observatory sites, and in 1903 investigated sites in Southern California, Arizona and Australia for the Carnegie Institution of Washington. His favourable report on Mount Wilson was largely responsible for the selection of that site for the now famous observatory there. In Argentina his investigations were continued, and his trip to South Africa has already been mentioned.

In 1905 he headed the very successful Lick Observatory eclipse expedition to Egypt. His later eclipse experiences were not so fortunate. In 1912 he conducted an expedition from La Plata to Alfenas in Brazil, but a storm prevented observations. In 1925 at Geneva, New York, he sat in the basket of a balloon prepared to ascend under perilous conditions to observe the eclipsed Sun from an elevation above the clouds, but expert balloonists forbade the flight.

Throughout his life Hussey took an active share in astronomical organisations. He served as President of the Astronomical Society of the Pacific, and as Secretary of the American Astronomical Society. He was a member of the Mexican Astronomical Society, the American Mathematical Society, the Seismological Society of America, Sigma Xi, the International Astronomical Union, and was a Fellow of the American Association for the Advancement of Science. In 1912 he received the honorary degree of Sc.D. from Brown University, of Providence, Rhode Island.

In 1895 he married Ethel Fountain of Santa Rosa, California, who died in 1915, leaving one son and one daughter. Two years later he married Mary McNeal Reed, widow of Professor Reed, of Ann Arbor, by whom he is survived.

He was elected an Associate of the Society on 1903 November 13.

L. J. C.

PROCEEDINGS OF OBSERVATORIES.

The following reports of the proceedings of Observatories have been received from the Directors of the several Observatories, who are alone responsible for the same.

Royal Observatory, Greenwich.

(Director, Sir Frank Dyson, K.B.E., Astronomer Royal.)

Transit-Circle.—The number of transits observed during the year 1926 is 11,606, including 149 of the sun and 99 of the moon. The observations are reduced to epoch 1925.0 as far as 1926 July. The ledgers of clock and azimuth stars are complete to the end of 1925, and the zone star ledgers are complete to the end of 1924. The investigation of division errors, mentioned in last year's report, terminated in 1926 January, and gave results in close accordance with previous determinations.

Altazimuth.—The observation of transits across the prime vertical of stars in Boss's Preliminary General Catalogue has been continued, and 2375 transits were observed during the year. The programme is nearly complete, and the observations will cease at the end of January 1927.

Cookson Floating Zenith Telescope.—Two hundred and sixteen plates were taken for variation of latitude during the year. They are fairly well distributed through the year. The measurements and reductions are complete up to the end of August 1926. The results for the year 1925 were published in the *Monthly Notices* for March. A final reduction of the observations for the second period of seven years has been begun.

28-inch Refractor.—During the year 462 observations of 290 double stars were secured. Arranged according to separation, they are:—

Under 0".5	78 observations.
0".5–1".0	149 ,,
1".0–2".0	108 ,,
Over 2".0	127 ,,

A catalogue of those double stars which have been observed on at least 3 nights, similar to that published in the 1920 volume, has been prepared and will be published in the 1925 volume, which will be distributed this year.

On Sunday nights and on other nights when the instrument is not in use for double-star observations, it is employed by Dr. W. H. Stevenson for the observation of faint variable stars. He obtained a few observations of Mars during the Opposition, but the weather was generally unfavourable.

Thompson Equatorial.—During the year 771 plates have been taken for parallax with the 26-inch refractor and 1028 have been measured.

The parallaxes of 26 stars were published in the *Monthly Notices* for 1926 November.

The 30-inch reflector, with a 7-inch prism crossed by a coarse objective grating, has been used for the determination of the relative colour temperatures of B- and A-type stars. The stars have been photographed in pairs, each pair consisting of a B-type and an A-type star photographed at approximately equal altitudes: 101 such pairs have been secured and measured in the micro-photometer. In addition, 24 pairs have been secured and measured for the determination of the effect of atmospheric absorption, each pair consisting of 2 stars photographed at different altitudes. The present programme is nearly complete, and the results will be communicated to the Society.

Astrographic Equatorial.—During the year 51 fields were photographed through the glass for the determination of proper motions of stars in the Greenwich Astrographic Zones. These 51 fields are made up of 14 in Zone $+69^\circ$ and 37 in Zone $+71^\circ$. The measurement of the area from 64° to 70° is now complete. In addition, 4 plates of the Nova in Nebula N.G.C. 4303, and 2 plates of the new variable star in Ophiuchus were secured. Two plates of the Pleiades were taken for Professor Hertzsprung. A note on the Nova in N.G.C. 4303 was published in the *Monthly Notices* for June.

Short-Focus Cameras.—In July a camera with a Ross portrait lens of 17 inches focal length and working at $F/5\frac{1}{2}$ was mounted on the astrographic telescope. This was replaced in November by 2 cameras, each with a triplet objective of 20 inches focal length and working at $F/5.6$. The objectives were an Aldis aeroplane lens, and an Aviar lens constructed by Messrs. Taylor, Taylor & Hobson. These cameras, which belong to Mr. Merton, were used by him to obtain plates of Comet Comas Solà, of which he has measured and reduced eight.

Miscellaneous Equatorial Observations.—Six disappearances and 1 reappearance of stars occulted by the moon were observed. Comet 1926f (Comas Solà) was observed on two nights with the Sheepshanks equatorial.

Photoheliograph.—Photographs of the sun were obtained on 245 days at Greenwich and 342 days at the Cape. On 8 days photographs were not taken at either Observatory, and they are being supplied from photographs taken at Kodaikanal. A new enlarging lens, supplied by Messrs. Ross, Ltd., has been fitted to the 9-inch Thompson Photoheliograph, and as a result a marked improvement in definition is shown near the sun's limb.

The mean daily spotted area, corrected for foreshortening, is approximately 1350 millionths of the sun's hemisphere, an increase of over 50 per cent. on that for 1925.

Clock and Time-Service.—A new standard clock (Shortt No. 11), similar to the free-pendulum clock (Shortt No. 3), has been purchased, and was set up in May. With the exception of the period June 10 to June 30, Shortt No. 3 has been used as standard clock throughout the year. Both clocks are performing very satisfactorily.

Hourly time-signals to the Post Office and half-hourly time-signals to the British Broadcasting Company have been maintained. The

regular service of Greenwich signals at $10^h 30^m$, $16^h 0^m$, and $21^h 0^m$ is now carried out from the Daventry Station.

Regular comparisons have been made of wireless time-signals from Eiffel Tower (morning), Nauen (noon), Bordeaux (evening), and Annapolis (17 hours). Signals from Annapolis have been registered on 269 days during the year.

Longitude Observations.—In connection with the international scheme for longitude determinations, in which about 50 observatories are taking part, observations were made with the small reversible transit B, which is fitted with a self-registering micrometer. A full night's work consisted of about 10 stars, which culminated south of the Zenith (Dec. -10° to $+40^\circ$) and about 4 stars above and 4 stars below pole, these being within 30° of the pole. For the determination of level error numerous observations were made with a striding level, while collimation was eliminated by reversing the instrument on all stars. Observations were secured on 4 nights in September, 14 in October, 15 in November, and 1 in December. These are being reduced with Eichelberger's star places, allowance being made for the small terms of lunar nutation. The reductions are nearly completed, and it appears that the clock is sufficiently accurate to allow of the interpolation of the clock error, so that the latter can be obtained on all nights during the period covered by the observations with a high degree of accuracy. This work has been entirely carried out by Dr. Jackson.

In connection with this scheme additional wireless time-signals were registered from Eiffel Tower, Bordeaux, and Annapolis throughout October and November. Only long-wave transmissions were recorded. The reception of the signals and the reading of the tape was done entirely by Mr. Bowyer.

Eclipses of the Sun.—Mr. Davidson was absent from 1925 November 6 to 1926 March 31, on the expedition to Sumatra to observe the eclipse of 1926 January 14. This expedition was arranged by the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies. Since his return he has been engaged on the measurement and study of the plates obtained.

It is proposed to observe the eclipse of June 29 next from a station in Yorkshire, kindly placed at our disposal by the Headmaster of Giggleswick School. The proposed programme consists of:—

1. Comparison of the intensities of the Calcium Triplet at $\lambda 8498$, $\lambda 8542$, and $\lambda 8662$ with H and K.
2. Spectrum of the chromosphere from D to the extreme red.
3. Direct photography of the corona, with a 6-inch lens of 45 feet focus, kindly lent by Mr. Worthington.

Printing.—The volume of Greenwich Observations for 1924 has been distributed. The printing of that for 1925 is well advanced. The volume of determination of effective wave-lengths of stars (referred to in last year's report) is passed for press, and should be distributed shortly.

Miscellaneous.—Dr. Jackson has given considerable attention to the reduction of Hornsby's observations.

Mr. G. Merton has worked regularly at the Observatory throughout

the year. He has completed a determination of the orbit of the Comet Skjellerup (1922, I), and has shown its identity with Comet Grigg (1902, II). This work will be published in *R.A.S. Memoirs*, 64, pt. 3.

Royal Observatory, Edinburgh.

(Director, Prof. Sampson, F.R.S., Astronomer Royal for Scotland.)

As hitherto, close attention has been given to the determination of time, both with the transit-circle and by daily comparisons with the microchronograph of the four principal clocks, Riefler No. 258, Shortt No. 0, Shortt No. 4, and Leroy No. 1230. The last named was put in the hands of the maker for readjustment in June and received back into use in July.

The installation for observing and recording wireless time-signals has worked satisfactorily, the signals from Bordeaux, Nauen, and Annapolis being observed regularly. The Daventry signal from Greenwich at 10.30 is also taken.

During October and November additional signals, organised in connection with the world longitude scheme of the Commission for Longitudes by Wireless Telegraphy of the International Astronomical Union, were taken. Favourable weather permitted a good series of transit-circle determinations over the same period.

With the Cooke 6-inch photo-visual telescope and objective prism the spectra of stars down to the third magnitude are under reobservation, with a view to confirming and extending the investigation already made. In the spring a reconstruction of the garden dome, in which the instrument was housed, was undertaken and the telescope was dismounted. An examination showed that the middle lens of the object-glass was badly spotted. It was sent to the maker to be repolished. On its return the instrument was mounted in the west dome in place of the 24-inch reflector which was taken down. With the new mounting some trouble has been experienced in obtaining spectra with even trails. Some new gear has been introduced into the clock-work which it is hoped will solve the difficulty.

The laboratory work with the Koch photometer on the law of blackening of photographic images has been continued, and further results have been published.

The solar spectroscope has continued in use for the purpose of obtaining plates for the determination of the solar rotation.

Measures of the magnitudes of stars on the Perth W.A. Astrographic Plates have been continued. With regard to the publication of these measures, the position remains unchanged.

Seismological and meteorological observations have been carried on.

Dr. M. R. Madwar worked at the Observatory as a research student until the time of his return to Egypt.

Royal Observatory, Cape of Good Hope.
(Director, Dr. H. Spencer Jones, H.M. Astronomer.)

Reversible Transit-Circle.—Observations of the programme commenced in April 1925 have been continued. This includes all stars south of -30° Dec. and brighter than $7^m.5$, together with the zodiacal stars observed in the *Cape Catalogue* for 1900. The observations during the year comprise :—

Observations of Right Ascension :—

Meridian Transits	11,856
Determinations of collimation	114
" " level	917
" " azimuth	138
Observations of meridian marks	1,623

Observations of Zenith Distances :—

Determinations of zenith distances	11,543
" " runs	367
" " nadir	852
" " flexure	60

These include observations of the Sun on 203 days, of Venus on 113 days, and of Mercury on 63 days.

Current reductions are well advanced.

The preparation of a copy for press of the *First Cape Catalogue* for the Equinox, 1925, based upon the observations with the reversible transit circle during the period 1918-25, is in progress.

Old Transit-Circle.—Determinations of clock-error were secured on 204 nights for comparison with the clock-errors derived from the observations with the reversible transit-circle. The differences between the errors given by the two instruments show little evidence of fluctuating systematic discordances. The results are under discussion.

Heliometer.—Observations of the major planets at their oppositions have been continued. The following observations were secured :—

Opposition of Neptune .	48 obs. in distance	on 8 nights.
" " Saturn .	48 " " "	" 5 "
" " Jupiter .	44 " " "	" 5 "
" " " .	20 " " position angle	" 3 "
" " Uranus .	76 " " distance	" 5 "
" " Mars .	26 " " "	" 3 "
" " " .	8 " " position angle	" 1 "

Victoria Telescope.—The telescope was in use on 40 nights in conjunction with the four-prism spectograph and short camera. Twenty-four long exposure plates of the spectrum of Nova Pictoris were secured. A summary of the Cape observations of the Nova has been communicated to the Society. Fuller details will be published in the *Cape Annals*.

The spectograph was dismantled on March 15 and replaced by the photographic breech-end with a view to undertaking a programme of

stellar parallax determinations. Before commencing this programme, the instrument was thoroughly overhauled and several alterations made. Parallax observations were commenced on April 19. By the end of the year 1223 plates had been secured on 168 nights.

A ruling machine for ruling reference plates for measurement was constructed in the workshop. Measurements were commenced on June 25. By the end of the year 890 plates had been measured and 185 reference plates ruled.

The programme of observations includes mainly stars of large proper motion south of -10° Dec., including many faint stars.

The radial velocity determinations made with this instrument and not hitherto published in the *Cape Annals* are being prepared for publication.

Astrographic Telescope.—The following plates were taken with this instrument :—

Cape Astrographic Zones (-41° to -47°), 417 plates with 1668 exposures.

Comet Ensor (1925I), 10 plates with 20 exposures.

The fields of the Cape Astrographic Zones were photographed through the glass with a view to determining proper motions by comparison with the plates of the original series, and to deriving improved values of the magnitudes. 279 plates were measured for proper motion during the year. The measurement and reduction of zones -44° and -45° are now complete, whilst zones -41° , -42° , and -43° are in progress.

The blink-microscope has been used to search for large proper motions amongst the stars of magnitude fainter than the limit adopted in the micrometric determinations of relative proper motions, and to eliminate stars with sensible proper motion from the list of faint stars selected as reference stars in these measurements. Zones -41° to -46° are practically completed and the remainder as far as new plates have been secured.

Photoheliograph.—707 photographs of the Sun to supplement the Greenwich series were secured on 342 days. Visual observations for zero were made weekly.

All original negatives taken up to September 23 and duplicates to September 28 have been forwarded to Greenwich.

Occultations.—Four observations of disappearance at the dark limb, one of disappearance at the bright limb, and two of reappearance at the dark limb were secured.

A rediscussion of the occultation observations, published in Newcomb's *Researches of the Moon*, for the period 1821 to 1908, is in progress, the positions of the Moon being reduced to the basis of Brown's tables.

Time-Service and Wireless Time-Signals.—The clock, Shortt No. 10, obtained from the Synchronome Company, has been installed during the year. Some delay was involved owing to the clock being damaged in transit. A 59-beat break circuit has been fitted to the slave clock for the purposes of chronographic registration. The clock is performing satisfactorily.

Time-signals have been sent out regularly to the Post Office and to

the Broadcasting Company, as well as wireless time-signals *via* the Slangkop wireless station. An apparatus for the automatic emission of the international type of time-signal has been ordered from the firm of Belin of Paris.

The scientific rhythmic signals sent out from Bordeaux ($8^h 1^m$ to $8^h 6^m$ G.M.T.) were observed on 315 days. In addition, the special series of signals sent from Annapolis ($10^h 10^m$ to $10^h 15^m$ G.M.T.) in connection with the world-programme of longitude determinations during the months of October and November were observed on 36 occasions.

A short wave-length receiving set has been constructed in the workshop, but it was not possible to bring it into operation until towards the end of the longitude programme. A few comparisons with d'Issy (wave-length 32 metres) were secured. Observations of this station are being continued as regularly as circumstances permit.

Publications.—*Cape Independent Day Numbers* for 1928 have been published.

Cape Astrographic Zones, vol. 9 (-49°), has been passed for press up to R.A. $19^h 42^m$. The remaining sheets have been sent for revise. Vol. 11 (-51°): the whole zone has been received from the printer and sheets to R.A. $12^h 54^m$ have been sent for revise. These two volumes complete the Cape section of the *Carte du Ciel* work.

Photographic Magnitudes of the Cape Zone Catalogue.—The proofs of the sheets of this catalogue, which gives the photographic magnitudes of the 20,843 stars contained in the *Cape Zone Catalogue* for 1900, have been received from the printer up to R.A. $7^h 31^m$.

Personal.—Dr. Lunt retired in July on the completion of thirty years' service, during the whole of which time he was in charge of the Victoria Telescope. Mr. Wilkin was promoted to Assistant. Mr. Peirce was promoted to the higher grade of Junior Assistants. Messrs. Turner and Driver have been appointed to the two vacancies for Junior Assistants.

Armagh Observatory. (Director, Rev. Wm. F. A. Ellison.)

With the exception of the Mural Circle, all the instruments are in working order. The 10-inch Grubb refractor was used during the year principally for the measurement of double stars. Fifty-five measures of 23 pairs were made, many of them of faint stars which could not be measured with smaller instruments. The same telescope was employed from time to time for observations of the planets as they were visible.

Seventy-one transits of stars and 20 meridian observations of the sun for time purposes were made.

The 6-inch equatorial was in frequent use for solar, lunar, and planetary work. This telescope, the objective of which was made at the Observatory a few years ago, by the Director, gives images of very great purity and excellence, and is extremely useful. The crown lens

is composed of Messrs. Chance Bros.' new "Telescope Crown," which enables perfect correction for both spherical and chromatic aberration to be obtained with three equal curves, and one plane surface.

The 18-inch reflector was out of action during a part of the year owing to the wearing out of the cable of the driving clock. Difficulty was experienced in obtaining a new cable on account of the necessity for its being weather-proof, the weight being in the open. A suitable article was at last obtained from Messrs. Ottway & Co. of Ealing.

An Inspector of the Air Ministry visited the Observatory in September and tested the instruments of the meteorological equipment. As the result of his report, slight alterations have been made in the assumed index error of three of the standard thermometers. In two of the three, the result has been to reduce the index error to zero. As these thermometers have been in use at Armagh since 1868, this is a very satisfactory testimonial to them.

Recent researches by Mr. Robert Whipple into the history of some of the old Kew instruments in the possession of Armagh Observatory have resulted in some interesting identifications. One of the mean time clocks proves to have been the clock with which the observations of the transit of Venus in 1769 were timed, when King George III. and the royal party observed the transit at Kew. A curious old compound reflector by Short, a combination of Gregorian, Cassegrain and Newtonian, was the telescope with which the King observed.

Cambridge Observatory.

(Director, Professor A. S. Eddington, F.R.S.)

The photographic proper motions of faint stars measured during the last five years have been collected into a catalogue of 3275 stars which is being prepared for press. The whole series has been analysed for star-streaming, and determinations of the apices and velocities of the streams have been published (*Monthly Notices*, **87**, 122, 138). The position of the vertex of star-streaming is found to be R.A. $91^{\circ}7$, Dec. $+19^{\circ}9$. The usual tendency for faint stars to give a high declination of the solar apex is manifested, the position from these proper motions being $+43^{\circ}6$.

The catalogue of zodiacal stars from meridian observations made between 1900 and 1918 has now been completed and copy for press is being prepared.

The Sheepshanks Equatorial has been available for photographic work for only a small part of the year, 39 plates being taken through glass for proper-motion work and 9 plates for positions of double stars. During the remainder of the time the photo-electric photometer has been mounted and many trial observations have been made, but the apparatus is not yet working satisfactorily.

Solar Physics Observatory, Cambridge University.
(Director, Professor H. F. Newall, F.R.S.)

Spectroheliograph.—Photographs of the sun's disc in K_{232} light were obtained on 114 days (previous year, 105); and photographs of the prominences at the sun's limb were obtained on 94 days (previous year, 81).

The solar activity has continued to increase during the year, for the greater part in the zones 20° to 25° both N. and S., with occasional disturbances extending to latitudes as high as 35° and as low as 5° . This wide distribution in latitude is usually indicative of the approach of the maximum phase. Several disturbances of exceptionally great extent have occurred during the year, suggesting that the maximum may be a high one.

For the year 1925 October 1 to 1926 September 30, the director of the Kodaikanal Observatory has sent 327 spectroheliograms showing the sun's disc in K_{232} light.

By a recent agreement with the Astronomer-Royal, prints of the Greenwich series of daily photoheliograms are now received replacing those which, after a continuous supply for more than 45 years from the Indian Trigonometrical Survey Observatory at Dehra Dûn, were discontinued in June 1925.

Study of Sun-spot Records and Prominences.—The investigation of the evidence of the existence of related sequences of outbursts of sun-spots has been continued by the director with the assistance of Mrs. Beech. The material relates to the four 11-year cycles 1879–1923.

The records of prominences obtained at the Kodaikanal Observatory during the year 1925 and received in MS. through the kindness of Dr. Royds have been plotted in continuation of the previous observations. The whole series 1904–1925 is being examined with special reference to discontinuities in the recurrences of localised prominences.

Stellar Spectra.—The observation of the ultra-red region of stellar spectra is being continued on hypersensitised plates stained with Neocyanin and Kryptocyanin; and laboratory tests are being made for this purpose, as well as for the selection of plates most suitable for use at the eclipse of 1927 June 29.

A start has been made in photometric work to be directed to investigating the effects of rotation and expansion on the form of stellar absorption lines. A theoretical treatment of the problem has been developed, and in particular the relation between the true form of an absorption line and the form shown by a grating or prism spectrograph of finite resolving power has been investigated, in order to develop a system of corrections to the observed lines.

The work, referred to in last year's report, on the absorption lines in the spectra of stars of types G0, K2, K5, and M4 has been completed and published in a note communicated by Mr. Baxandall to the Society (*Monthly Notices*, 86, 524).

Other work is in hand on sun-spot spectra.

Meteorological Physics.—A series of observations has been made on the magnitude and predominating sign of the vertical electric currents

due to the point-discharge from an elevated metal point during the intense electric fields of showers and thunderstorms. The results obtained indicate that the predominating direction of these currents is upwards, *i.e.* that during such periods the earth loses positive electricity. From this, with other available evidence, it would appear that the typical cumulo-nimbus cloud is bipolar, the upper charge being positive. The work was initiated in the summer of 1925 by Professor C. T. R. Wilson, and is now in the charge of Mr. J. W. Wormell, recently appointed to the post of observer in Meteorological Physics.

Dunsink Observatory.
(Acting Director, Mr. Charles Martin.)

The time-service to Dublin has been continued as in previous years. The meridian circle has been used only for time determination, a comparison being made daily between Paris and Dunsink mean time.

The Observatory has been used mainly for teaching purposes, students being welcome in the daytime for instrumental instruction and any clear evening for observational work.

Durham University Observatory.
(Director, Mr. Harold Thomson, M.Sc.)

The weather during 1926 was again very unfavourable, and in consequence the available fine nights were devoted almost entirely to the variable star programme which now forms the principal work of the Observatory. The results have been communicated to the Variable Star Section of the British Astronomical Association. The usual meteorological records have been kept and communicated to the Meteorological Office.

Norman Lockyer Observatory, Salcombe Hill, Sidmouth.
(Director, William J. S. Lockyer, M.A., Ph.D., Major (Late R.A.F.).)

The 12-inch McClean prismatic camera has been in regular use for the usual routine photography of stellar spectra, and in addition has been used to obtain a series of spectra of α Ceti during this star's period of maximum brightness. A series of plates has also been taken with a view to improving the focus and other adjustments, especially in the red region. The Grubb electric control is now in good working order, and is very useful when working on faint stars. The 9-inch Kensington instrument has been used mainly on bright-line stars of special interest. The series of photographs of ϕ Persei (mentioned in the last report) was continued until after the completion of a whole cycle, and a similar series is being taken of the star H.D. 20336 *Camelopardalis*, which also shows periodically variable bright lines. Successful observations have been made on 140 nights. During the year 307 negatives have been obtained with the McClean prismatic camera, 104 with the Kensington instrument, and 9 with the fixed meteor camera. The reduced number

of photographs taken with these instruments was partly due to the absence of the Director in the months of November and December through illness.

The work on spectroscopic parallaxes has been continued in connection with stars of types B and A. Two papers have been prepared for presentation to the Society, one of which discusses the method of Adams and Joy for B-type stars and gives the parallaxes of 300 stars determined in this way, the other paper giving the parallaxes of 300 A-type stars by a similar method.

The work on bright-line stars has also been continued. A second paper on ϕ Persei has been communicated to the Society (*M.N.*, **86**, 474) discussing the results obtained from the series of photographs mentioned above. A paper has also been published on the spectrum of H.D. 20336 (*M.N.*, **86**, 614).

Magnitude and spectroscopic observations of α Ceti have been made at the period of maximum in October. A paper is being prepared discussing the results obtained at recent maxima.

From 1926 February 15, Mr. H. C. Woods, B.Sc., Ph.D., of University College, London, was appointed research student for twelve months, and took part in observational work and discussion of stellar spectra.

In view of the total Solar eclipse which will occur on 1927 June 29, a small transparent grating spectrograph with a 4-inch Zeiss triple objective (1:48) has been made and erected on the polar axis of a 12-inch siderostat. The instrument has been set up in the Observatory grounds, and several photographs of star regions for adjustment have been taken. It is proposed to erect this instrument somewhere on the line of totality in England, but the station has not yet been decided on. Owing to the short duration (24 secs.) of totality it is proposed to make only one exposure to secure photographs of (1) the corona and (2) the first order spectrum of the corona.

The Observatory is open to the public on Wednesday afternoons. The number of visitors who attended in 1926 was 235, including a visit from the Scientific Society of University College of the South West (Exeter).

The annual general meeting of the Norman Lockyer Observatory Corporation was held on 1926 June 23.

Radcliffe Observatory, Oxford.

(Director, Dr. H. Knox-Shaw, Radcliffe Observer.)

The programme of work with the 24-inch refractor on the proper motions of stars in Kapteyn's Selected Areas has been continued. During the year 31 plates on these areas have been taken, of which 21 have been passed for measurement. In addition, 5 plates were taken of Præsepe at the request of Dr. van Rhijn, and also 16 test plates. The large proportion of proper-motion plates, which it was found necessary to reject owing to incomplete exposure or to bad images, is an indication of the difficulty of carrying out in this climate an observational programme on stars as faint as the 15th magnitude.

Twenty-nine plates have been measured and the reduction of ten areas has been finished during the year. Of the 135 areas in the programme, 52 have now been completely photographed and proper motions derived for 20 areas. Efforts are being concentrated on alternate areas of the scheme, with the idea that these will provide, a few years before the whole programme can be completed, a fairly good representation of the Northern Hemisphere.

Study of the proper motions in the areas so far reduced has brought to light the existence of a systematic magnitude equation. Details of this will shortly be communicated to the Society. It is sufficient to state here that the cause has been traced to change in the adjustment of the two components of the object-glass.

It has been decided to publish periodically lists of all stars found to have annual proper motions as great as $0''.1$; the first of these will be found in *M.N.*, **86**, 342.

A number of visual observations were made of the brightness of a star (30.1926 Oph.) in Area No. 3 Special, found by Mr. Barrett to be variable over a range of about five magnitudes, and a note on it was communicated to the Society (*M.N.*, **86**, 706).

For a fortnight in January the telescope was affected by a periodic vibration of such an amplitude—the star images oscillated at times through more than $5''$ —that any work with it was quite impossible. It seems likely that it was a resonance effect caused by some gas engine, but all efforts to trace the engine failed.

Steady progress has been made with the reduction of Hornsby's meridian observations, in which Dr. Jackson is collaborating with the Director, the expenses of computing being met by a Government grant. The Right Ascensions of the standard stars have been completely reduced for the five years 1780 to 1784, and those of the Sun for the same period have been compared with Newcomb's tables; also the observed R.A.'s of the Moon and Planets have been derived. The main conclusions reached as yet are (a) that the corrections to Boss's Right Ascensions at that date for individual stars are small, only a few being as large as $0^s.05$; (b) that there is a very small periodic term indicated in the R.A. system with amplitude of the order of $0^s.01$; and (c) that there is a well-marked annual term in the Right Ascension of the Sun. Similar work for the six years 1774 to 1779 is also well advanced, as are the reductions of the declinations for 1780 to 1784. A comparison of the solar and stellar observations indicates that the correction to Boss's system of declinations does not exceed $0''.2$ at the equator for the year 1780.

The adopted longitude of the Observatory depends on transport of chronometers in 1842, and is believed to be in error by about half a second of time. Advantage was consequently taken of the special W/T time-signals transmitted in the autumn in connection with the international longitude scheme, and local time was determined with the transit-circle on seven nights in October.

Radcliffe Observations, **54**, containing the meteorological observations made in the five years 1921 to 1925, was published during the year.

University Observatory, Oxford.
(Director, Professor H. H. Turner, F.R.S.)

The printing of the Vatican section of the Astrographic Catalogue is nearing completion: the measures for zone $+56^{\circ}$ are all printed, and when this volume is completed there remains but one more of the ten which make up the section from $+64^{\circ}$ to $+55^{\circ}$. The plates for this section have been taken in Rome, and the measures on them made there: the reductions have been carried out at the University Observatory, leading to a large amount of the revision work of proof-reading: further, ledgers have been formed at Oxford by Miss Bellamy for the reference stars in the Helsingfors and Harvard A.G.C. catalogues, and the comparison of places from different plates in these ledgers has occupied Mr. Bellamy for a large part of his time recently.

Dr. Fotheringham, who retains his connection with the Observatory as honorary assistant, has spent much time in the investigation of the fluctuations in the moon's motion and related phenomena. He finds that there is a sympathetic variation in several elements of the solar system, some of which at any rate, especially the mass of Venus, cannot be explained by a variation in the length of the day, and he has revived the name "trepidation" for this general fluctuation. His papers on the subject have appeared in the *Monthly Notices*.

Several zones of the Astrographic Catalogue have been counted, and are being analysed. Analyses of a Sydney zone and two Melbourne zones have already been published.

The seismological reductions have been carried on with the kind financial help of Dr. Crombie, of the Department of Industrial and Scientific Research, and also of the Royal Society: five years (1918-1922) of the International Seismological Summary have by this time been completed, and the greater part of 1923 is in type. The residuals of the five years 1918-1922 for the P and S waves have been corrected and discussed: the chief deductions are, first, the clear recognition of Gutenberg's wave, which passes through the liquid core of the earth as a P wave, but outside the core both before and after travels as an S wave; secondly, the detection of a possible double wave at distances near 35° from the epicentre.

The latter duplicity is most clearly marked in the S wave, but there is a corresponding phenomenon in the P wave. The earlier of the two waves is of such a character that it might explain the results for the angle of emergence which puzzled Galitzin. The results of this investigation have been printed in the Geophysical Supplement of the *Monthly Notices*.

Other work has been done on these results for 1918-1922, but has not yet been brought to a satisfactory conclusion.

Some much-needed repairs in the Observatory have been carried out, and an extension of the library is in prospect, with a basement for seismographs. Of these there are now two components at Oxford, mounted in the Clarendon Laboratory by kind permission of Professor Lindemann; transference to the Observatory would be a great convenience.

Preparations are being made in conjunction with the Radcliffe Observer for observation of the eclipse of June 29. A hospitable invitation has been received from the borough of Southport, and a site selected in the ground of the boys' school. The prospect of the eclipse has led to a good deal of correspondence of all kinds.

Imperial College, South Kensington.
(Assistant-Professor H. Dingle.)

The work of the Observatory has been confined to the instruction of students.

Laboratory research, mainly concerned with the spectra of the lighter elements, has been continued. Professor Fowler and Mr. Freeman have almost completed an investigation of the spectrum of ionised nitrogen (N II). Assistant-Professor Dingle has continued the study of the spectrum of fluorine, the first results of which (dealing with the spectrum F I) have been communicated to the Royal Society. Mr. Beals has investigated the Zeeman effect for silver, and published an account of the observations and deductions therefrom in the *Philosophical Magazine*. The study of Zeeman effects is being continued by Messrs. Daly and Symons. Mr. Ganesan has completed his work on the second spectrum of neon, which includes the measurement of a large number of lines not previously recorded. The structure of the band spectrum of magnesium hydride has been under investigation by Mr. Pearce.

Stonyhurst College Observatory.
(Director, Rev. E. D. O'Connor, S.J.)

Mr. Joseph Burns, who for upwards of thirty years has with great loyalty and efficiency performed the duties of meteorological clerk, has had to retire owing to advancing years and enfeebled health. His place has been taken by Mr. Wilfrid Brown.

The meteorological, magnetic, and seismological records have been carried on as usual, and the results forwarded to the official centres.

Observations of the solar surface were made on 281 days, and include 284 drawings. Of these 244 are complete, showing all spots and faculae; of the remaining 40, 31 are complete for spots. The mean daily disc area of the spots (in units $1/5000$ of the disc) was 5.33, as compared with 3.53 in 1925 and 1.36 in 1924. Only two spotless days were observed—July 17 and 18.

Work on the relation between solar activity and magnetic disturbances has been continued. In this connection a remarkable feature was noticed in the magnetic storm of 1926 January 26, suggesting a double periodicity in the fluctuations of horizontal force, and attention was directed to this in a brief note communicated by Father Rowland at the March meeting of the Society.

University of London, University College Observatory.
(Director, Prof. L. N. G. Filon, F.R.S.)

The work of the Observatory has been carried on as in previous years. A new theodolite by Wild was purchased in the spring with a view to testing its suitability for precise determination of longitude and latitude. A large number of observations were made by Messrs. Gregory and Richards in which serious systematic errors of the instrument were evident. These were traced to faulty construction in the mechanism by which the level is read. A number of transits were also taken with a view to obtaining an independent determination of longitude exactly comparable with that obtained with the theodolite. No new sun plates were obtained with the grating during the year, but progress has been made with the measurement and reduction of plates taken previously. Miss E. Williamson has now joined the staff as an honorary assistant.

Dominion Observatory, Ottawa, Canada.
(Director, R. Meldrum Stewart.)

Meridian Work and Time-Service.—Fundamental work on the previous programme was continued until August. There were obtained 2523 observations of stars, 42 of planets, and 71 of the sun. During the latter part of the year all the energies of the division were devoted to the international longitude programme. At Ottawa observations were made with the meridian circle and a 3-inch field transit; at Vancouver two field transits were employed. At Vancouver a half-second gravity pendulum was kept swinging during practically the whole period as a check on the rate of the clock; individual swings were of 24 hours duration.

The time-service has been maintained as in previous years without substantial alterations; there are now 622 dials and 2 tower clocks operated or controlled by 4 primary clocks and 15 secondary clocks, as well as various relays, chronographs and seismograph shutters.

Wireless time-signals were received regularly throughout the year from Annapolis, Lafayette, and Nauen, and signals were transmitted twice a week through the Ottawa broadcasting station CNRO. During the longitude operations signals were received from Lafayette, Annapolis, Bellevue, and Honolulu at both Ottawa and Vancouver, and in addition from Nauen at the former and Saigon at the latter.

Solar Physics.—About 200 nine-strip spectroscopic observations were made, the weather being exceptionally cloudy or hazy. Over 700 measurements of the solar rotation, centre and iodine spectra photographed in 1914 and 1916, were made. Tables were computed and a device constructed for determining components of the orbital motion of the Earth to any point on the solar disc. Measurements of the annual rings in a section of a tree released by a receding glacier, wherein it is supposed to have lain for many thousands of years, reveal the 11.5-year period.

The 15-inch Equatorial.—Radial velocity work was continued on

bright cepheids, some spectroscopic triple systems, and the stars σ Scorpii and ϕ Persei; in all, 660 spectrograms were secured. The cepheids ζ Geminorum, δ Cephei, and RT Aurigæ were specially observed for radial velocity, variation of period, variation of ionisation, and for velocities from different lines, high or low level, ionised or neutral. A photo-electric photometer was received and preliminary tests of it made.

Photographic Photometry.—About 300 plates were made in accordance with an international arrangement for the determination of the light-curves of a selected list of cepheids. Co-operative work on this programme was begun in April. Nearly 300 plates of the comparison and standard stars in cepheid fields were made and 15 fields reduced.

Seismology.—Most of the 361 earthquakes recorded were comparatively small. The regions most affected were the East Indies, especially near the Solomon Islands, and the Pacific Ocean near Central America, with some activity, too, in the Northern Pacific. In co-operation with the Geodetic, Geological, and Topographical Surveys and one of the power companies in the province of Quebec, preliminary work was done in connection with the establishment of two seismological stations. Some further data on the earthquake of 1925 February 28 were secured and the report is being prepared, all the material being now in hand. The routine work of the division has gone forward without interruption.

Terrestrial Magnetism.—The magnetic work consisted mainly of observations for secular change. Declination, inclination, and horizontal intensity were observed at 32 repeat stations and 9 new points distributed over the region bounded by the Canada-United States boundary and latitude 50° N. and by longitude lines 68° and 98° W.

Gravity.—During the summer 8 gravity stations were established along the Pacific Coast, including 4 on Vancouver Island and 1 on Graham Island. Isostatic reductions for 20 stations previously established in British Columbia were made.

Publications.—Four publications were prepared during the year, one of which is in press.

Dominion Astrophysical Observatory, Victoria, B.C.
(Director, Dr. J. S. Plaskett, F.R.S.)

The permanent staff of the observatory remains the same as last year. Mr. W. H. Christie and Mr. R. M. Petrie were temporarily employed for the University vacation of five months as observing assistants.

Observing.—The weather during the past year was slightly more favourable than the average, a total of 1958 spectra being obtained in 1353 hours on 217 nights as compared with the average for seven years of 1653 spectra in 1269 hours on 206 nights. On 155 nights five or more plates were obtained with a total 1822, while on 62 nights less than five were obtained with a total of 136. On several nights in addition, though the dome was opened and exposure started, no usable spectra were obtained. As in previous years two hours of the

time of the telescope on each Saturday evening have been given to visitors, a privilege very fully made use of, especially in the tourist season.

Researches.—The observing time of the director, as for the past two years, has been occupied chiefly in continuation of the work on the B-type stars, obtaining spectrograms of all Bo to B5 stars north of -10° and brighter than 7.5 visual magnitude. This programme, in which Mr. Pearce is collaborating, is making good progress, about two-thirds of the required spectra having been obtained, of which practically all are measured. The radial velocities of about 120 of these B-type stars have been completed, and a computation of the residual velocities from these and the 83 of Mr. Pearce gives on the average about 13 km. per second, twice that usually assigned to the B's. The work on ν Sagittarii referred to last year has been completed, the results showing that the enormous masses ascribed by Ludendorff to this star are illusory, that the lines of this complex spectrum composed of a complete cA2p metallic, a complete B3 helium spectrum and complex nova-like hydrogen lines, all take their origin in a single stellar atmosphere. Combined with the discussion on this star are descriptions of two other peculiar spectra, H.D. 50820, a similar combination of an F and a B3 spectrum with complex hydrogen, and H.D. 45910, a very peculiar variable spectrum normally diffuse B3 with P Cygni hydrogen, and with the occasional superposition of an enhanced A2 spectrum, an almost exact replica of α Cygni. The description of these three peculiar and similar spectra is in press as vol. 4, No. 1, of the Observatory Publications.

Mr. W. E. Harper has continued the observation of A-type stars in the H.R. programme, the spectrograms to be used eventually for spectroscopic parallaxes, a preliminary paper being presented to the Royal Society of Canada. The radial velocities of about 400 of these A-type spectra have been measured, and it is proposed to give in the final publication both radial velocities and spectroscopic parallaxes. The period and orbital elements of the following eight spectroscopic binaries were obtained: H.R. 2962, Boss 1275, H.R. 4750, 33 Piscium, 71 Aquilæ, Boss 5579, H.R. 8169, β Scuti. Considerable work was done also on changes in the elements of Boss 3511.

Mr. H. H. Plaskett obtained some wedge spectra of B-type stars for intensity distribution and a number of wedge spectra of α Cygni, Vega, and some B-type stars for the determination of line intensities. Some further spectra of the peculiar envelope emission star Z Andromedæ were also obtained, which were all measured, the wave-lengths accurately determined and the peculiarities discussed. Preliminary measures of the intensities of several lines in Vega and the sun were made in preparation for a symposium at the A.A.A.S. meeting at Oakland in June. Final computation of the line intensities in the Orion Nebula and N.G.C. 7027 were made in continuation of the investigation on the nebulae, which is making satisfactory progress.

Mr. J. A. Pearce has devoted the greater part of his time to the observation and measurement of B-type spectra in collaboration with the director and results for 83 stars are completed. Work on the O-type

eclipsing variable H.D. 1337 has been completed and printed. It is the second most massive system known, the components, practically in contact, having masses 36.3 and 33.8 times the sun, with densities .0027 and .0091, absolute magnitudes -5.9 and -4.8 at a distance of over 3000 parsecs. Two additional O-type binaries with double lines have been investigated, H.D. 19820 and H.D. 209481, and the projected masses obtained. An investigation on the co-existence of stellar and "stationary" calcium in early type B-stars has been undertaken, and three stars whose orbits were obtained from the calcium lines alone are being re-observed.

Mr. S. N. Hill, computer, besides measuring many B-type spectra, has obtained orbits of two interesting spectroscopic binaries, κ Draconis and H.D. 214240. The former star was extensively observed at Ann Arbor and an orbit obtained by Baker. Mr. Hill's period 0.890 days, which is certainly correct, is only about one-tenth of Baker's, and the probable error per plate is only ± 1.7 km., a very low value for this class of spectrum. H.D. 214240 has an interesting double-lined spectrum, primary B3, secondary B8, and the orbit, probable masses, luminosities, and distance have been obtained.

Mr. W. H. Christie obtained the orbits of two binaries, H.R. 5752, H.R. 6506, appearing as vol. 3, No. 14. Further observations both spectroscopic and photometric were made concurrently of the peculiar short-period variable 12 Lacertæ. The measures, which it is hoped will co-ordinate the velocity and light variation, are now being discussed and will appear later.

Mr. R. M. Petrie observed principally A-type stars on Mr. Harper's programme, measured the radial velocity of several and obtained the orbits of two binaries, H.R. 4535, Boss 3555, which will appear as vol. 3, No. 16.

Publications.—There have appeared and been distributed vol. 3, Nos. 9 to 12 inclusive, while Nos. 13 to 17 inclusive, and vol. 4, No. 1 are in press.

Helwan Observatory, Ministry of Public Works, Egypt.
(Director, Mr. P. A. Curry.)

On the appointment of Dr. M. R. Madwar as Resident Astronomer, the Reynolds reflector was brought into use again towards the end of November.

Dr. H. Knox-Shaw spent December at the Observatory to advise on the future course of work with the telescope. During December the telescope was used on twelve nights. In addition to several test plates, a few photographs of Nebulæ were taken and unsuccessful search was made for Comet Grigg-Skjellerup.

The rhythmic W/T signals from Bordeaux were observed regularly throughout the year.

During October and November, in connection with the International Longitude Scheme the Bordeaux evening signals were also observed and transits were taken three to four times a week.

The Standard clock throughout the year was Shortt No. 1, which has proved a distinct improvement on the Riefler clock.

The usual meteorological, magnetic, and seismological observations were made.

Kodaikanal Observatory.
(Director, Dr. T. Royds.)

1. The routine work has been continued on the same lines as in former years. As a result of the failure of the north-east monsoon, the weather conditions have been more than usually favourable. Photoheliograms were obtained on 345 days, calcium flocculi plates on 344 days, calcium prominence plates on 311 days, and H_{α} flocculi plates on 328 days. During the year a total of 2895 spectroheliograms were obtained. Under the auspices of the International Astronomical Union, prominence and H_{α} spectroheliograms were collected from other Observatories whenever complete observations were not possible at Kodaikanal, and the combined results were published in the half-yearly bulletins.

2. Plans have been completed for abolishing the two mirrors at present used to deflect the sun's image into the H_{α} spectroheliograph. The necessary parts are now being manufactured in England. When this alteration has been made, the H_{α} spectroheliograph will be reconstructed to secure greater stability. The designs are ready.

3. Considerable time has been devoted to the collection of material for a review of prominence activity, but this is not yet ready for the press.

4. Three unusual features of solar activity during the year are noted here in the order of their remarkability.

(1) An unusually bright filament on the sun on 1926 February 22. In point of brilliance, of extent, and of completeness of the observations, this example exceeds any other in the Kodaikanal record.

(2) A dark marking of long duration attained on 1926 February 21 an area which, when corrected for foreshortening, exceeded any previously recorded at Kodaikanal.

(3) An eruptive prominence on 1926 December 19, which rose to a height of over 14 minutes.

5. Observations of the luminosity of the night sky with Lord Rayleigh's apparatus have been continued throughout the year.

6. The annual report for 1925 and Kodaikanal Observatory bulletins Nos. 78 and 79, dealing with the prominence observations of 1925, were published and distributed during the year. A paper on "Unusual Bright Filaments on the Sun on 1926 February 22," was communicated to the Society (see *Monthly Notices*, **86**, 380, 1926).

Nizamiah Observatory, Hyderabad.
(Director, Mr. T. P. Bhaskaran, M.A.)

The main programme of work carried on with the Astrographic Equatorial was the same as in the previous year. One hundred and

fourteen photographs were taken with the telescope, including 46 plates which were exposed through the glass for the determination of P.M. by direct comparison with the earlier negatives. Fifty-seven plates have been measured and the preliminary reductions of 33 plates have been completed.

The printing of vol. vi. (Decl. -22°) of the *Hyderabad Astrographic Catalogue* has proceeded steadily. One hundred and sixty pages of proof have been read and passed for press.

The Grubb 15-inch Telescope.—Observations of variable stars (mostly with faint minima) have been continued. Sixty-four variables (53 long period and 11 irregular) were under observation, and 1374 estimates of visual magnitudes have been made to the end of the year. The observations of 28 stars have been copied and forwarded to the Variable Star Section of the B.A.A. As in former years, very few observations could be secured during the monsoon months, June to October, owing to continuous cloudy weather.

Occultations.—Thirteen occultations of stars by the moon were observed :—

Disappearance	.	9
Reappearance	.	4

Transit Instrument.—Observations for determining clock corrections have been continued as usual.

Seismology.—The Milne-Shaw Seismograph registered 79 shocks during the year and the monsoon microseisms were prominent on the records for 26 days. The seismograms to the end of 1925 September have been studied, and the readings have been forwarded to the University Observatory, Oxford.

The usual meteorological observations and other routine duties have been carried on as before.

There has been no change in the staff of the Observatory.

Union Observatory, Johannesburg.
(*Union Astronomer, Dr. R. T. A. Innes.*)

The Staff was increased by the appointment of Mr. C. Jackson in December. During the year, joint colloquiums of the staffs of the Yale Southern Station and the Union Observatory were held on thirty-seven occasions, twenty-five here and twelve at the Yale Telescope. Several of these were attended by Professor G. Struve of the Neubabelsberg Observatory, Dr. C. G. Abbot of the Smithsonian Institution, and Dr. Perez of the Lourenzo Marques Observatory. The visit of Dr. Abbot to South Africa was in connection with his search for a suitable location for an additional solar observatory; a site in South West Africa was ultimately selected. Dr. G. Horn d'Arturo of the Bologna Observatory also visited the Observatory.

26½-Inch Grubb Visual Refractor.—This instrument has been in continuous use throughout the year. From the middle of March to the beginning of July the telescope was placed at the disposal of Professor

G. Struve so that he could continue his series of observations of the inner satellites of Saturn, this planet being now too far south to allow of useful observations from Berlin. Professor Struve secured about 450 measures of pairs of the satellites during this period.

In conjunction with the Yale Southern Station, it has been arranged to continue the observations of the satellites until Saturn is again well observable from Berlin. The Union Observatory share of the work will be limited to visual measures of Enceladus and Mimas.

The work on Saturn naturally interfered somewhat with the double-star programme, but this was otherwise quite successful. Of the zones from -19° to the South Pole, it might be said that, over about one-fifth of the area, all stars to the 9th magnitude have been examined systematically. The work may be summarised as follows:—

1516 measures of known double stars
754 measures of new double stars.

In this connection, mention is pleasurably made of the great assistance rendered by Dr. W. H. van den Bos of Leiden Observatory. Amongst the discoveries made with the large refractor was that of ψ Sagittarii as a double star (by Dr. van den Bos) with a measured distance of $0''.21$. This discovery was communicated to Dr. Aitken, who confirmed it with the 36-inch Lick refractor and measured the distance as $0''.18$. This discovery, which is only one of many, shows that the dividing power of the telescope is equal to its theoretical limit and is a testimony to the work of Sir Howard Grubb and Mr. Armstrong.

Occultations of Stars.—The programme of the last few years was maintained, *i.e.* to observe during each lunation about 4 or 5 disappearances of stars at the dark limb when the Moon is about 7 days old, and the dark edge is still easily visible. In addition to these a few occultations of N.A. stars were observed. In all 90 occultations were observed by one or more observers.

The occultation results since the introduction of Brown's Tables, roughly grouped, give:—

	Time Error.	Error of Moon's Mean Longitude.
	s	"
1923.4	+14.6	+8.0
1923.6	13.9	7.6
1923.9	13.6	7.5
1924.1	14.9	8.2
1924.4	16.3	9.0
1925.4	14.4	7.9
1925.6	13.1	7.2
1925.8	13.0	7.1
1926.2	13.3	7.3
1926.5	13.4	7.4
1926.8	13.2	7.3

The accuracy of these results is limited by the weakness of the star positions, but Dr. Guthnick of the Neubabelsberg Observatory has

most kindly undertaken to have the places of the stars concerned redetermined there.

9-Inch Grubb Refractor.—This telescope has been in constant use for occultations, eclipses of Jupiter's satellites, Comets Ensor and Blathwayt, measures of the wider double-stars, and, on one night a week, for visitors.

Franklin-Adams Star-Camera.—During the year 407 plates were taken with this instrument with a total exposure time of 141.8 hours. The distribution of the plates was as follows :—

Minor planets and star maps	104 plates
Variable star regions	270 „
Cluster regions	27 „
Miscellaneous	6 „

150 photographic observations were secured of 40 minor planets, of which 7 were new planets. With the 6-inch guiding telescope attached to the Star-Camera, the following visual observations were made :—

- 33 occultations of stars by the moon
- 23 eclipses of Jupiter's satellites
- 5 miscellaneous satellite observations.

Union Observatory Circulars.—During the year, Circulars Nos. 65 to 70 were issued. No. 65 gave proofs of the variability of the rotation of the Earth as disclosed by the Transits of Mercury, the motion of the Moon, eclipses of the satellites of Jupiter and the motion of the Sun ; No. 66 contained, amongst other matter, drawings of Mars made at the opposition of 1924 ; No. 68 contained a discussion of the observations of α Centauri as a double star with a new orbit ; No. 69 contained a paper on the dichotomy of Venus, which is shown to occur at the geometric epoch ; and No. 70 illustrated the application of Cowell's Method to the movement of the Pons-Winnecke Comet at the time of its close approach to the Earth in 1927. A paper on Cowell's Method was published also in *Astronomische Nachrichten*, 5463-5464. It makes the revolutionary but strictly scientific and economical suggestion that the planetary and lunar ephemerides should be computed by Cowell's Method instead of from the present tables. Circular No. 71 is in the hands of the Government printer : it will have as an appendix tables of X and Y corresponding to each degree of the mean anomaly and every 0.01 of the eccentricity from 0.00 to 1.00. The whole of the MS. of these tables is ready, but a little checking by differences remains to be done.

The present state of the work of issuing Star Maps of the southern sky is as follows :—

Maps already issued	239
Maps in Government printer's hands	35
Maps still to be made	282
Total	<u>556</u>

Loose-leaf Catalogue of Southern Double-Stars.—A start has at last been made on this work, and the Catalogue is being issued in hourly sections as run off.

The whole work of producing the Catalogue is done at the Observatory, using a typewriter and a rotary mimeograph. By this means quickest publication is secured and there is also very great economy.

The hours so far distributed are 0^h-3^h, and 16^h. The MS. for the whole is complete, but the work with the 26½-inch telescope makes changes every day, and already some of the leaves issued require replacing, but this will not be undertaken until all the hours are issued. A sort of finality cannot be attained until the surveys with the 27-inch Lamont Refractor now being erected at Bloemfontein, and with the 26½-inch refractor here have been completed.

Melbourne Observatory.

(Director, Dr. J. M. Baldwin, Government Astronomer.)

The clock vault has been completed by the installation of a thermostat and fan, and a more accurate means for reading off the amplitude of the free pendulum Shortt 5 has been put in. Apart from small variations in this amplitude the functioning of the clock has been most satisfactory, the pressure inside the case remaining at 0.72 inch of mercury for month after month with no perceptible change. The case will be opened and the pivots of the impulse arm will be examined for friction in the immediate future, and it is hoped that the irregularity will be removed.

An apparatus for the reception of wireless time-signals has been installed, and was in use at the end of the year in connection with the international longitude programme.

The fourth volume of the *Astrographic Catalogue* (plates with centres along -71° and -72°) is ready for the printer, and money is provided on the estimates for its publication.

Proofs of the first volume of the *Astrographic Catalogue* (zones -65° and -66°) and of the *Fourth Melbourne General Catalogue* have been revised and returned to the printer, and proofs of the appendices to the Fourth Catalogue, and of the Fifth Catalogue and its appendix are now being read, as well as the early sheets of the second volume of the *Astrographic Catalogue*.

The Hourly Values of the Magnetic Elements at Toolangi in 1924 were published during the year and are being distributed.

"The Melbourne Observations of Comet Reid" were published in the *Monthly Notices*, and 1505 observations of long-period variable stars were forwarded to Harvard College Observatory and for publication in *Popular Astronomy*.

The astrographic telescope was used for securing further triple-exposure chart plates, some plates with centres along -66° , and some on the Nubecula Major, as well as a few catalogue plates to replace plates that have had to be rejected.

During October and November special observations of time were

made in connection with the international longitude determination, and signals from Bordeaux and Saigon were received regularly.

Inquiries having shown that the Time Ball at Williamstown was no longer used by shipping, the dropping of the ball was discontinued at the end of August.

At the end of the year a Milne-Shaw seismograph was ordered to replace the present Milne instrument.

Dominion Observatory, Wellington, New Zealand.
(*Director, Dr. C. E. Adams, Dominion Astronomer.*)

1925-26.

Astronomical Observations.—Observations of the meridian transits of the stars and of the sun have been made for the purpose of controlling the time service.

Reception of Wireless Time-Signals at the Observatory.—Wireless time-signals were received from Honolulu, Malabar, Java, Nauen, Bordeaux, and Saigon.

The wireless time-signals received at the Observatory generally agreed with the Observatory clock within one second of time.

Time-Service.—An improvement was made in the time-service, and the signal at 23 hours, G.M.T. (10.30 a.m., N.Z.T.), is now sent every day of the year. The improved service began on August 2.

Sun-spots.—Sun-spot observations are made every day when the weather permits, except Sundays, and the reports are published in the *Monthly Notes of the New Zealand Astronomical Society*. The total number of observations during the calendar year 1925 was 271. Spots were seen on 156 occasions, and 127 separate groups were observed.

Annular Eclipse of the Sun, 1925 July 20 to 21.—An important annular eclipse of the sun took place on 1925 July 21, and the only land, with the exception of some small islands in the Pacific, from which the annular phase was visible, was at the extreme north of New Zealand. Arrangements were accordingly made for observing the eclipse from Te Pahi, a homestead near the North Cape, and for the taking of photographic records.

Successful photographs of the eclipsed sun before, during, and after the annular phase were obtained.

The late Mr. Thos. Allison, F.R.A.S., who accompanied the Government Astronomer on the expedition, observed the sun with his own telescope for the time of commencing and ending of the annular phase, the duration being 160 seconds. Mr. Allison observed for Baily's Beads, the corona, and for any prominences, and reported that there was no trace of any of these, due probably to the light from the annulus, which was 63 seconds wide, and to the slight clouds that covered the sun at this time.

Title of Observatory.—In order to conform with the titles of Government Observatories elsewhere, the title of the Observatory was altered to "Dominion" Observatory.

The late Sir James Hector's association with the Observatory is recorded by a notice plate attached to his photograph in the Observatory building.

Mr. R. Barker's Observatory, Cheshunt.

Sixteen observations were made on Uranus with the 12.6-inch Calver equatorial. On five occasions an equatorial bright zone was seen, bounded by parallel dusky bands.

Dark belts were also seen encircling the poles.

Many observations of Jupiter's satellites I., II., III., IV. show pronounced ellipticity of outline, especially III., which also displayed dark markings.

The shadow of II. in transit was once distinctly oval.

Forty-five drawings of Mars were obtained.

Some attention has been given to observations of the certain lunar formations for seasonal changes.

Mr. Scriven Bolton's Observatory, Bramley, Leeds.

The search for variable stars in the Pleiades and the Hyades has been continued during the year. The 6-inch Dallmeyer lens was used, as hitherto. The Pleiades were photographed on 115 nights and the Hyades on 56. Seventy-four stars in the Pleiades group belong to the Cepheid variable class. The behaviour of background stars is usually more erratic than that of the members. The results will be communicated to the Society.

Sixteen negatives were obtained of the new Algolid situated $1\frac{1}{2}^{\circ}$ preceding γ Andromedæ. The mean period since 1924 works out at $1^d\ 8^h\ 34^m\ 33^s$.

*Lee Observatory, Chorlton-cum-Hardy.
(Mr. A. A. Buss.)*

The sun has been observed telescopically and spectroscopically on 217 days. A few of the observations deserve special mention.

Activity was initiated during January with a most brilliant chromospheric display attending the west-limb passage of the large N.L. Spot-group on January 31. Its disc passage was marked in the night of the 25/26 by a thunderstorm, when an auroral display was expected, and the same thing took place during its return passage in February. The fine spot-display on the disc during the last days of February and the beginning of March was distinguished by a pronounced yellow tinging of the northern penumbral slope of one of the large active spots, and on March 9 a fine, if short, display of aurora borealis was observed.

Other exceptional eruptive displays were seen on the limb during April and May, while on June 23 the east limb at p.a. 60° showed a perfect facsimile in H_{α} of Professor C. Störmer's diagram of converging lines of force over a spot on the limb (see *Mt. Wilson Contributions*, No. 109, p. 31). In another chromospheric display the very substance of a prominence was seen to be quickly withdrawn towards a spot-place, a few minutes sufficing to see the previously solid and fair-sized

prominence gradually, but rapidly, extinguished. On May 20 a most curious spherical prominence was observed near p.a. 270° , about 5000 miles in diameter, surrounded by a concentric ring about 1000 miles from the core. This unusual formation quickly broke up into irregular masses. Similarly on June 2, near p.a. 285° – 290° , a very active chromosphere showed for a few minutes a considerable area of what seemed photospheric matter raised to an altitude of some thousands of miles, yielding white light only, so intensely brilliant did it shine for a few minutes. The summer months were distinguished by one of those remarkable instances of an obviously connected group of prominences showing for several rotations alternately on the east and the west limbs. Several of these chromospheric displays showed the full complement of reversed lines; in fact, in a few instances lines were seen which are not contained in Young's Tables.

Amongst the many disc-eruptions seen there were again a few, showing the companion-line to H_α , on the red side, which I believe to be the companion-line first established by Michelson with the Interferometer (see *Light Waves and their Uses*, p. 78). In these appearances of the companion to H_α , the principal line invariably shows a kind of "washed" displacement effect towards the red side, reaching the companion, and cut off sharply by the latter, the companion-line itself showing for the time very conspicuous, very dark and straight, but in length only commensurate with the extent of the displacement effect.

Another disc-eruption specially to be mentioned is one which took place in the early afternoon on October 13, and which has also been recorded by the spectroheliograph at Meudon.

The period under review afforded numerous instances of pronounced preponderance of prominences on the western limb as compared with the eastern limb, yet it remains an observational fact that a very high percentage of spots experience a check, or even suppression, during transit, but may revive before reaching the west limb. Again, many observations were made of areas of faculæ showing the helium line D_3 in absorption, a feature which has also attracted the attention of the Meudon observers.

Wolsingham Observatory.
(Rev. T. E. Espin.)

The examination of stars in the selected zones for new double stars has been continued, as in previous years, and the results, together with micrometrical measures of neglected double stars, have been communicated to the Society.

Mr. A. M. Newbegin's Observatory, Sutton, Surrey.

Observations for solar prominences were made on the usual lines. The first eight months' results indicate a very steady average of activity. In September a pronounced increase in the mean daily number was recorded, culminating in October; this was maintained with but little diminution to the end of the year.

Ninety-three observations yielded 1413 prominences, with a slight preference for the northern hemisphere and eastern limb.

Metallic displays were recorded on fifty-four occasions, 63 per cent. being on the east limb. The distribution north and south of the equator was exactly equal. A few of these prominences were of more than usual interest, but in the main there was nothing very spectacular.

Drawings of sunspots have been made on 104 days, showing the chief characteristics of each group and their positions. Many of the larger spots have been examined in the Littrow-type spectroscope. The C line was always reversed and often displaced, but on no occasion was a violent disturbance seen.

Attempts have been made to photograph the spot spectrum, but so far these attempts have not proved successful.

Mr. B. M. Peek's Observatory, Herne, Kent.

The Observatory was successfully re-erected at Herne at the beginning of the year. In April a 150-mm. O.G. by Zeiss was mounted on the Dallmeyer equatorial which previously carried the 5-inch, and has proved to be a first-rate glass. On this has also been mounted an astro-camera by Cooke of 19-inch focal length working at F/4, kindly lent by Mr. Percy Morris, and towards the end of the year a Watson anastigmat of 19½-inch focus at F/5.8 was purchased and has since been mounted as a check on the Cooke.

Physical observations of the major planets have been continued, particularly of Jupiter and Mars, and the results will be communicated to the respective sections of the B.A.A. With the 12-inch reflector photometric observations of 4 Novæ and 3 U Geminid variables were continued.

Ten occultations of stars by the moon were observed and recorded. Photographs were obtained of Comets Ensor and Comas Solà, and plates were exposed in search of Comet Giacobini-Zinner. Several mutual eclipses of Jupiter's satellites were observed and the results have been published in the *B.A.A. Journal*.

*The Rev. T. E. R. Phillips's Observatory,
Headley Rectory, Epsom.*

The usual programme of work was followed in 1926, viz., observations of the planets and variable stars, and the measurements of double stars with the 8-inch Cooke refractor belonging to the Society.

Of the planets, Jupiter and Mars claimed most attention, and both exhibited features of more than ordinary interest.

In the case of Jupiter systematic observations were begun early in June, when it was seen that the planet presented a very similar appearance to that observed in 1919, the S. Tropical Disturbance, the S. component of the S. Equatorial belt, and the Red Spot hollow having disappeared. Moreover, as the apparition advanced the vapours which

were apparently concealing these features spread still farther south, and during the later months of the year the greater part of the S. Temperate belt, a large portion of the S.S. Temperate belt, and even parts of the S. polar shading had faded or were completely obscured. As in 1919, however, the Red Spot itself remained visible and had gained considerably in intensity. Its longitude (System II.) at opposition was 21° as compared with 89° in 1925, but a marked retardation of its rate of drift set in during the summer.

The apparition of Mars was a specially favourable one for Northern observers, since the planet was well placed in the sky and attained an angular diameter of $20''$. The weather, too, prior to November was favourable, and exceptionally good seeing conditions were experienced on several nights. More fine detail was accordingly detected than at any previous apparition covered by the Headley observations. Special mention may be made of the astonishing changes in orientation, form, and position of Solis Lacus, the intense darkness and growth of Lacus Nubis, and developments and changes in the regions of Nepenthes-Thoth, Cerberus, Elysium, Mare Sirenum, and Mare Erythræum. Pandora Fretum which had been very attenuated in 1924 was again broad and dark.

The appearance of clouds was frequently observed, and especially a grey mistiness which at the end of October and beginning of November lay over Hellas and obliterated the peak of Mare Hadriacum for some days. Similar obscuring vapours were found still lying over the S. portions of the Syrtis Major and neighbouring regions at the next presentation of this part of the disc a month later. A specially interesting feature was the visibility of Nix Olympica which was detected on November 5.

Dr. R. L. Waterfield worked regularly on the planets during August, September, and October, and Mr. P. M. Ryves, who was in England for a short time, made a number of observations chiefly of variable stars.

The usual meteorological observations were continued. The most interesting feature recorded was the abnormally heavy rainfall—amounting to 6.84 ins.—in November, followed by a quite exceptional deficiency in December, when the total was only 0.41 in.

Dr. W. H. Steavenson's Observatory, West Norwood.

Observations were made on 159 nights during the year.

1629 observations of 28 long-period variables and 205 observations of 13 novæ were obtained. Most of this work was done with the 6-inch refractor, but some of the fainter objects were regularly observed with the 28-inch equatorial of the Royal Observatory, Greenwich, by kind permission of the Astronomer Royal. The number of nights on which this instrument was used was 44.

The observations of novæ made during 1925 have been communicated to the Society. Some photometric observations of the variable star discovered at the Radcliffe Observatory in 1926 have also already appeared in the *Monthly Notices*, in a paper by Mr. Barrett.

Physical observations of comets Van Biesbroeck and Blathwayt were made early in the year both at Norwood and Greenwich, and similar observations of comet Comas Solà were obtained during November and December.

Unfavourable weather interfered considerably with the observations of Mars near the time of opposition. A few interesting views were obtained with the 28-inch telescope of the Royal Observatory; but, on the whole, the results secured were less satisfactory and complete than those of 1924.

NOTES ON SOME POINTS CONNECTED WITH THE RECENT
PROGRESS OF ASTRONOMY.*Discovery of Minor Planets in 1926.*

One hundred and fifteen planets were discovered in 1926, as follows :—

Month and Designation.	Day of Month.	Magnitude.	Discoverer.	Month and Designation.	Day of Month.	Magnitude.	Discoverer.	Month and Designation.	Day of Month.	Magnitude.	Discoverer.	Month and Designation.	Day of Month.	Magnitude.	Discoverer.
Jan.				Apr.				Aug.				Oct.			
AA	9	15.7	W _I	GC	2	14	R	PC	4	13.5	B ₂	TA	3	13.4	R
AB	10	15.5	W _I	GD	5	13.0	D	PD	4	12.8	B ₂	TB	4	13.7	R
AC	10	15.5	W _I	GE	5	14	R	PE	4	12.5	W ₂	TC	4	13.1	R
AD	11	13.0	R	GF	5	14.0	R	PF	6	12.5	W ₂	TD	4	14.0	R
AE	10	13.5	W _I	GG	5	13.5	R	PG	9	13.3	N	TE	4	13.7	R
AF	12	14.7	B _I	GH	6	14.0	R	QA	16	12.5	D	TF	4	13.8	R
AH	12	14.3	B _I	GJ	6	14	R	QB	18	..	D	TG	5	14.0	R
AJ	12	14.6	B _I	GK	6	14	R	QC	18	12.0	D	TH	5	13.6	R
AK	12	13.8	R	GL	6	14	R	QD	30	14	R	TJ	6	14.0	R
AL	14	16	W _I	GM	6	13.7	R	QE	30	14	R	TK	6	13.4	R
AM	15	13.6	S _I	GN	11	13.5	D	Sept.				TL	6	14	R
BA	16	13.8	N	GO	13	14	R	RA	1	13.4	R	TM	1	13.0	B ₂
Feb.				GP	13	13.8	R	RB	1	13.8	R	TN	10	13.7	B ₂
CA	14	13.8	R	GQ	13	14	R	RC	5	13.9	R	TO	1	13.5	B ₂
CB	12	13.0	B ₂	GR	13	15	W _I	RD	5	13.9	R	UA	31	12.5	B ₂
CC	12	13.8	B ₂	GS	13	13.5	R	RE	5	13.4	R	Nov.			
CD	10	13.5	B ₂	GT	13	13.4	R	RG	9	13.5	R	VA	3	13.7	R
Mar.				GU	14	13.6	R	RH	10	..	D	VB	3	14	R
EA	5	15	W _I	GV	14	13.8	R	RJ	11	13.8	R	VC	11	13.5	D
EB	5	16	W _I	GW	14	13.8	S _I	RK	13	13.2	D	VD	10	13.7	R
EC	12	13.6	J	GX	14	13.8	S _I	RL	13	13.0	D	VE	10	13.9	R
ED	7	13.2	S ₂	GY	14	13.7	N	RM	14	13.2	N	VF	10	13.9	R
FA	16	14	R	GZ	14	13.5	S _I	RN	15	13.2	N	VH	4	13.0	N
FB	16	14	R	May				RO	15	13.7	N	VJ	11	13.0	D
FC	18	13.6	R	JA	9	13.5	R	RP	9	13.0	W ₂	WA	25	14.0	W _I
FD	18	14	R	JB	9	14	R	RQ	9	13.3	W ₂	Dec.			
FE	18	14	R	JC	8	..	D	RR	9	14.0	W ₂	XA	7	14.3	W _I
FF	18	14.3	W _I	KA	17	11.5	W ₂	SA	17	13.0	D	XB	7	13.5	R
FG	18	14.6	W _I	KB	18	13	W ₂	SB	28	13.5	D	XC	5	11.8	V
Apr.				Aug.				SC	29	13.5	N				
GA	1	16	W _I	PA	1	12.5	R								
GB	2	15.5	W _I	PB	9	12.0	W _I								

Also add the following discovery to 1925 :—

1925, JA, May 15, O. Struve. It was at first thought to be identical with 884.

The initials stand for: B1=W. Baade, Bergedorf; B2=S. Beljajsky, Simeis; D=E. Delporte, Uccle; J=B. Jekhowsky, Algiers; N=G. Neujmin, Simeis; R=K. Reinmuth, Königstuhl, Heidelberg; S1=G. Shajn, Simeis; S2=J. Comas Solà, Fabra, Barcelona; V=P. Vocca, Pino Torinese; W1=M. Wolf, Königstuhl, Heidelberg; W2=H. E. Wood, Johannesburg.

The following identities have been established: 255=1924TA; 270=1926VG; 294=1926AG; 297=1924SK; 396=1925RH; 520=Yerkes, No. 21; 573=1926RF; 658=1926WB=1918 Σ 153 (re-observed 1926 Nov.); 962=1916 Σ 60; 982=Yerkes, No. 23; 1029=1916 Σ 59; 1035=1913TF; 1041=1906 WF; 1044=1907YC.

The following identities are probable: 395=1926 SA; 1020=1926TO; 1926EA=1926AD; 1925NA=1924QD; 315 possibly=1926 AH.

Of the identities given as probable in *M.N.*, 85, 347, 1924 SG=597, 1924SK=297, are confirmed. 1922MX is not 220; 1924PN is not 835; 1924 QO is not 750.

Planet 1924 SU has been cancelled as erroneous.

The following planets have received permanent numbers: 1924TE=1047; 1924TP=1048; 1925RB=1049; 1925RC=1050; 1925SA=1051; 1925VD=1052; 1925WA=1053; 1925WD=1054; 1925WG=1055.

The following planets have been named:—

701 Oriola	790 Pretoria	840 Zenobia	879 Ricarda
702 Alauda	792 Metcalfia	841 Arabella	881 Athene
705 Erminia	798 Ruth	842 Kerstin	882 Svetlana
706 Hirundo	799 Gudula	843 Nicolaia	885 Ulrike
709 Fringilla	801 Helwerthia	845 Næma	889 Erynia
713 Luscinia	804 Hispania	851 Zeissia	890 Waltraut
714 Ulula	805 Hormuthia	853 Nansenia	891 Gunhild
726 Joella	806 Gydenia	854 Frostia	892 Seeligeria
729 Watsonia	807 Ceraskia	855 Newcombia	893 Leopoldina
731 Sorga	808 Merxia	856 Backlunda	894 Erda
732 Tjilaki	809 Lundia	857 Glasenappia	896 Sphinx
735 Marghanna	811 Nauheima	858 El Djézair	897 Lysistrata
736 Harvard	812 Adele	859 Bouzareah	898 Hildegard
737 Arequipa	815 Coppelia	860 Ursina	899 Jokaste
739 Mandeville	816 Juliana	861 Aida	900 Rosalinde
740 Cantabia	817 Annika	862 Franzia	915 Cosette
741 Botolphia	818 Kapteynia	863 Benkoela	917 Lyka
747 Winchester	820 Adriana	864 Aase	934 Thuringia
755 Quintilla	821 Fanny	865 Zubaida	962 Aelög
756 Lilliana	826 Henrika	866 Fatme	984 Gretia
757 Portlandia	829 Academia	868 Lova	1000 Piazzia
767 Bondia	830 Petropolitana	871 Amneris	1001 Gaussia
770 Bali	832 Karin	872 Holda	1002 Olbersia
772 Tanete	833 Monica	873 Mechthild	1021 Flammario
774 Armor	835 Olivia	874 Rotraut	1026 Ingrid
775 A. L. Lumière	837 Schwarzschilda	875 Nymphe	1035 Amata
784 Pickeringia	838 Seraphina	878 Mildred	1052 Belgica
785 Zwetana	839 Valborg		

The names of 1000, 1001, 1002 commemorate the three astronomers to whom we owe the discovery and subsequent recovery of *Ceres*, the first minor planet. The nomenclature is now very nearly complete up to No. 900.

The following interesting planets were re-observed in 1926: 132 Aethra, 279 Thule, 433 Eros, 617 Patroclus.

H. Hartog gives revised elements of 132 in *A.N.*, 228, 294; the period is 4.22892 years.

AJ 873 contains elements of 1908 EKa, together with ephemerides for several oppositions, in the hope of other images being found.

H. Osten gives tables for 583 Klotilde in *A.N.*, 228, 1. *A.N.*, 227, 33, contains a study of the distribution of the orbits in distance, and the gaps at certain regions, by A. Klose.

Dr. G. Stracke has brought out a very useful work of reference "Identifizierungsnachweis und Elemente der Kleinen Planeten" (*Veröffentlichungen des Astronomischen Rechen-Instituts zu Berlin-Dahlem*, No. 45). It contains full details of the date of discovery of all the minor planets, together with their elements, notes of identity, and other particulars.

We note that, besides the 1055 numbered planets, the discovery of about 1200 others has been reported. While several identities among these are probable, it may be taken that the number of planets whose existence is known is little short of 2000.

Professor M. Wolf heads the list of discoverers with 216 numbered planets and 297 unnumbered ones; K. Reinmuth is second with 69 and 136 respectively. J. H. Metcalf, J. Palisa, G. Neujmin have passed the century, while A. Charlois has 99 discoveries (all numbered).

A. C. D. C.

Report on Comets in 1926.

Several of the comets of 1925 were visible for a long time in 1926, and were well observed at Yerkes, Bergedorf, etc.

1925 *a* (Shajn, Comas Solà) and 1925 *b* (Reid) were followed at Yerkes till late in 1926, when their magnitudes were 15 and 16.5 respectively (*Pop. Ast.*, 35, 48). 1925 *c* (Orkisz) was observed at Bergedorf till May 2 (mag. 16) and at Yerkes till May 12. M. Beyer contributed a paper on the brightness of this comet in 1925 to *A.N.*, 227, 71; he found traces of a periodic variation in twenty-seven days, which he conjectured to be connected with the Sun's rotation. 1925 *f* (Borrelly) was observed at Bergedorf till April 4 (mag. 14) and at Yerkes till May 11. 1925 *g* (Brooks) was observed at Bergedorf till March 15 (mag. 14). 1925 *h* (Faye) was observed at Yerkes till March 14. 1925 *j* (van Biesbroeck) was very well observed at several observatories, the latest observation to hand being on June 10 at Yerkes. Its light kept up in a remarkable manner, the magnitude being given as 8 at Bergedorf on March 10, five months after perihelion. The orbit appears to be decidedly hyperbolic (see table on pp. 296-7).

1925 *k* (Peltier-Wilk) was observed at Yerkes till 1925 December 30;

the distance between its orbit and that of the Earth near the descending node is some four million miles; the Earth passes this point on August 14.

1925 $l = 1926$ III. (Ensor) was such a conspicuous telescopic object in the southern hemisphere before perihelion that it was confidently expected that it would prove very interesting when it came north. Thus Mr. W. Reid stated that its magnitude was 6.5, and its tail 1° in length. However, it suffered a complete collapse. The only visual observation in Europe was made from a balloon sent up at Leningrad by the Mirovédénie Society on February 23: they described it as a dim, indistinct spot, 8' to 10' in diameter, magnitude 5. On March 6 and 7 they failed to find it. Photographs were secured at Bergedorf on March 16 and 20, with exposures of two and a half hours, using the Lippert astrograph. The photograph of March 16 is reproduced in the *Observatory* for May. There was no trace of a nucleus; there was a fan-shaped tail half a degree long, the sides of the fan being inclined 10° to each other. The tail forked 20' from the narrow end, assumed to be the head. The position angle of the tail was 250° , the magnitude about 12. The comet was again photographed at Bergedorf on April 3 and 13, and appeared as an exceedingly faint nebulosity covering a large area. The lag of the tail behind the produced radius vector was 80° on March 16, 70° on April 3, 57° on April 13.

Ref. No.	Year and Number of Comet.	Name.	T.	ω .	Ω .	i .
385	1889 II.	Barnard	June 10-805070	$236^\circ 5' 36''$	$310^\circ 43' 4''$	$163^\circ 50' 28''$
451	1902 II.	Grigg-Skjellerup	July 2-843	$347^\circ 37' 9''$	$223^\circ 47' 43''$	$8^\circ 39' 0''$
458	1904 I.	Brooks	Mar. 7-138756	$53^\circ 32' 31''$	$275^\circ 47' 25''$	$125^\circ 7' 43''$
..	1913 O	Holmes	July 12-66872	$21^\circ 47' 20''$	$329^\circ 31' 59''$	$19^\circ 34' 37''$
533	1919 II.	Finlay	Oct. 15-48261	$318^\circ 8' 54''$	$46^\circ 55' 40''$	$3^\circ 23' 44''$
541	1921 II.	Reid	May 9-943084	$64^\circ 28' 16''$	$268^\circ 15' 32''$	$132^\circ 7' 4''$
545	1922 I.	Grigg-Skjellerup	May 15-195212	$355^\circ 0' 57''$	$215^\circ 28' 24''$	$17^\circ 30' 47''$
560	1925 j	van Biesbroeck	Oct. 3-00066	$106^\circ 25' 13''$	$334^\circ 34' 30''$	$49^\circ 19' 38''$
562	1925 g	Brooks (2)	Nov. 1-88950	$195^\circ 44' 32''$	$177^\circ 25' 2''$	$5^\circ 33' 9''$
564	1925 k	Peltier-Wilk	Dec. 7-27378	$126^\circ 7' 31''$	$140^\circ 43' 16''$	$144^\circ 36' 27''$
565	1926 I.	Blathwayt	Jan. 2-99349	$328^\circ 22' 45''$	$136^\circ 5' 1''$	$128^\circ 21' 30''$
566	1926 II.	Kopff	Jan. 28-55	$19^\circ 41' 47''$	$263^\circ 55' 21''$	$8^\circ 42' 11''$
568	1926 IV.	Tuttle	May 2-065	$206^\circ 57' 50''$	$269^\circ 48' 29''$	$54^\circ 59' 20''$
"	"	"	Apr. 27-65	$206^\circ 58' 52''$	$269^\circ 47' 6''$	$54^\circ 57' 20''$
569	1926 V.	Finlay	Aug. 7-9	$320^\circ 34' 48''$	$45^\circ 18' 0''$	$3^\circ 26' 0''$
570	1926 VI.	Giacobini-Zinner	Dec. 11-66	$171^\circ 44' 8''$	$195^\circ 56' 35''$	$30^\circ 43' 14''$
571	1926 VII.	Reid	Dec. 30-5375	$224^\circ 45' 0''$	$108^\circ 42' 0''$	$83^\circ 40' 0''$
..	1927	Neujmin	Jan. 16-208	$193^\circ 43' 15''$	$327^\circ 39' 12''$	$10^\circ 37' 44''$
..	1927 a	Blathwayt	Feb. 12-7196	$228^\circ 51' 42''$	$18^\circ 39' 44''$	$90^\circ 31' 44''$
..	1927	Comas Solà	Mar. 22-1992	$38^\circ 37' 31''$	$65^\circ 36' 29''$	$13^\circ 45' 40''$

Mr. B. M. Peek took a photograph on March 10, which shows a very faint and ill-defined image of the comet. It was too doubtful to be accepted without confirmation, but this was afforded by the Bergedorf results.

Passing to the comets discovered in 1926, Dr. W. Baade detected Tuttle's periodic comet (1926 *a* = 1926 IV.) on January 12 at Bergedorf. It was of magnitude 15.5, brightening to 12 in April. Perihelion passage was on April 28.74, 0.89 days later than the prediction of N. Idelson and M. Musselius, 3.32 days earlier than that of Dr. J. Stobbe. No post-perihelion observations have as yet come to hand. This comet has been observed at every return since its discovery as a periodic comet in 1858 (also in 1790). The shortest observed period is 13.4 years, so the value 12.1 years given in the *Annuaire du Bureau des Longitudes* is very much in error.

Mr. T. B. Blathwayt of Braamfontein, near Johannesburg, discovered a new comet (1926 *b* = 1926 I.) on January 16. Observations were quickly secured at Johannesburg, Lick, and Algiers. It was moving rapidly northward and was well observed till April 9 at Yerkes, April 12 at Bergedorf. On February 6 it was described as a round nebulosity with poorly defined nucleus, total light 9.5 magnitude. On February 16 it passed very close to Castor. On March 17 the nebulosity was 10" in diameter with faint central condensation:

Ref. No.	log <i>q</i> .	Period in Years or Eccentricity <i>e</i> in Hyperbolic Orbits.	Equinox.	Computer.	Reference.
385	0.353254	579000	1890.0	F. K. Zweek	<i>A.N.</i> , 227, 221.
451	9.87247	4.8265	1902.0	G. Merton	<i>R.A.S. Mem.</i> , 64, 74.
458	0.432613	<i>e</i> 1.001365	1904.0	M. S. Kasakov	<i>Moscow Ann.</i> , 8, 1.
..	0.369591	7.332524	1910.0	J. Polak	<i>A.N.</i> , 228, 313.
533	0.005395	6.693600	1919.0	S. Hasunuma	<i>A.N.</i> , 228, 87.
541	0.003659	13857	1921.0	G. Peisino	<i>A.N.</i> , 228, 149.
545	9.948872	4.98004	1922.0	G. Merton	<i>R.A.S. Mem.</i> , 64, 96.
560	0.195007	<i>e</i> 1.002442	1925.0	A. Dubiago	<i>A.N.</i> , 226, 399.
562	0.269922	6.926862	1925.0	D. Martinoff	<i>A.N.</i> , 227, 191.
564	9.882805	..	1925.0	L. Berman	<i>A.J.</i> , 864.
565	0.129210	..	1926.0	Oikawa, etc.	<i>Proc. Imp. Acad. Tokyo</i> , 2, 149.
566	0.229958	6.57901	1926.0	F. Kepinski	<i>Warsaw Circ.</i> , 4.
568	0.012890	13.5416	1925.0	J. Stobbe	<i>B.Z.</i> , 1925, 44.
„	0.013098	13.5357	1925.0	N. Idelson, etc.	<i>B.Z.</i> , 1925, 46.
569	0.024713	6.8510	1926.0	S. Kanda	<i>A.N.</i> , 228, 88.
570	9.99726	6.5832	1926.0	F. R. Cripps	<i>B.A.A. Handbook</i> , 1926.
571	9.87703	..	1927.0	J. Halm	<i>I.A.U. Telegram</i> .
..	0.126461	5.42946	1925.0	G. Neujmin	<i>Pulkovo Bull.</i> , 98.
..	0.02522	..	1927.0	H. E. Wood	<i>I.A.U. Telegram</i> .
..	0.248639	8.516453	1926.0	A. C. D. Crommelin	<i>B.A.A.J.</i> , 37, 108.

magnitude 15.5. No appreciable deviation from a parabola was detected.

The periodic comet detected by Kopff in 1906 and reobserved after two revolutions in 1919 was due at perihelion in late January 1926, but was too near the Sun for observation at that time. But Professor M. Wolf succeeded in photographing it at Königstuhl on July 13 (1926 *c* = 1926 II.), nearly six months after perihelion. It was fainter than magnitude 16, round, with very slight condensation, diameter about 40". Perihelion passage was January 28.55, being 5.08 days later than F. Kepinski's prediction. It was approaching the Earth, so its brightness did not fall off rapidly. Observations were obtained at Königstuhl, Bergedorf, and Yerkes, which will facilitate its recovery at the much more favourable return of 1932.

Finlay's periodic comet, discovered in 1886 and observed again in 1893, 1906, 1919, was expected about June 1926. But Mr. S. Kanda, applying perturbations by Jupiter to the orbit for 1919 calculated by Mr. S. Hasunuma, found that these would delay perihelion passage by six weeks, bringing it to August 7.2. Diligent photographic search was made during July by Messrs. Hargreaves, Merton, and Peek, but Dr. Stobbe was the first to detect it at Bergedorf on August 3 (1926 *d* = 1926 V.), its magnitude being 11.5. It was a nebulous patch without nucleus, 1' in diameter. A somewhat doubtful image was subsequently found on a plate taken by Mr. Hargreaves on July 21 (*B.A.A.J.*, 36, 308). The comet was well observed for some months at several observatories. The perihelion passage was only 0.7 day later than Kanda's prediction.

Mr. Wilk of Cracow Observatory announced a cometary object of magnitude 6 on September 1, moving East 1° in four minutes, which is just the motion that a stationary object in our atmosphere would exhibit relatively to the stars. It was not seen anywhere else, and its cometary nature is doubtful; it may have been a meteor trail.

Mr. F. R. Cripps calculated the perturbations by Jupiter of the comet Giacobini-Zinner, discovered by the former in 1900, and recovered by the latter, two revolutions later, in 1913. The results were published in *B.A.A. Handbook*, 1926, and indicated December 7.91 as the date of perihelion. Messrs. Hargreaves, Merton, and Peek again searched diligently, but Dr. Schwassmann was the first to detect the comet at Bergedorf on October 16, its magnitude being 14 (1926 *e* = 1926 VI.). Images were subsequently found on plates taken there on October 6 and 8. It was approaching both Earth and Sun, so its brightness increased considerably, rising to magnitude 11 in December. Perihelion passage was December 11.66, $3\frac{3}{4}$ days after the prediction. Part of the discordance may be due to perturbations by the Earth in 1913, which were not taken into account. In 1900 the comet's orbit was $5\frac{1}{2}$ million miles distant from that of the Earth, but in 1926 the orbits intersected, the Earth being at the crossing-point on October 10, the comet two months later. On October 9, Messrs. W. F. Denning, J. P. M. Prentice, and A. King saw several bright meteors apparently connected with this comet, the accordance in the radiant being good (*M.N.*, 87, 104).

Professor J. Comas Solà discovered a comet (1926 *f* = 1927 —) of magnitude 12 on November 5 at the Fabra Observatory, Barcelona, in the course of his photographic work on minor planets. An image of it was subsequently found on a plate taken two hours earlier by Mr. G. Neujmin at Simeis. It had a coma 2' in diameter with slight central condensation, and a tail in P.A. 240° . Attempts at parabolic orbits showed large residuals, and it was soon found to be a member of Jupiter's comet family, having an orbit not unlike that of Spitaler's comet, 1890 VII., for which a period of 6.4 years was found, but which was not seen again. The facts that Tisserand's criterion is well satisfied by the two comets, as Mr. L. E. Cunningham noted (Harvard postcard 13), and that the elements of 1926 *f* indicate a near approach to Jupiter about 1912 May, favour the identity. The new comet will remain well placed for observation until next May, so a very good determination of mean motion should be obtainable. Perihelion passage is on 1927 March 22, $4\frac{1}{2}$ months after discovery.

The periodic comet Neujmin (2) = 1916 II. [Neujmin (1) = 1913 III. has a period of eighteen years] was observed for $3\frac{1}{2}$ months in 1916 and found to have a period of 5.414 years, the discoverer himself deducing definitive elements. It was not seen at the 1921 return, being badly placed. Mr. G. Neujmin thought it possible that a faint object photographed on 1920 November 16 might be identified with it, but recent evidence is against this conjecture.

Both he and Mr. B. F. Bawtree prepared search ephemerides for the present return, their dates for perihelion passage being 1927 January 12.648 and January 2.37 respectively. The comet was found by Mr. Neujmin at Simeis on November 5, magnitude 14.5 (1926 *g* = 1927 —). The date of perihelion indicated is 1927 January 16.208. The small error of $3\frac{1}{2}$ days in the discoverer's prediction after a lapse of two revolutions is very creditable. The comet was also observed by Professor G. van Biesbroeck at Yerkes, but remained a faint and difficult object.

The comet 1927 *b* (Reid) passed perihelion on 1926 December 30 according to elements telegraphed from South Africa, so is provisionally named 1926 VII. It was found on January 25 by Mr. William Reid at Capetown, being his sixth cometary discovery. Its magnitude was 8.0: observations were secured at the Cape Observatory on the following night. It was in S. Decl. 57° , but soon travels northward, and promises to be visible in Europe in March.

Mention may be made of Mr. G. Merton's work on the comet Grigg-Skjellerup (1902 II. = 1922 I.). He has rendered the identity of the two practically certain, and prepared an ephemeris for the 1927 return. His work is appearing in *Memoirs*, lxiv.; his orbits for 1902 and 1922 are given in the preceding table.

In this table the reference number is that of Galle's *Cometenbahnen* and its Sequel (*B.A.A. Memoirs*, xxvi., Part 2); it is continued in order for more recent comets. T is in G.M.T. up to the end of 1924, and in U.T. after that.

I have altered the arrangement of the table in order to avoid such a dislocation as occurred in the last Annual Report: the last three lines

of the comets at the bottom of p. 225 were placed at the top of p. 226 without any indication of the comets that they referred to.

The Jupiter perturbations of Holmes's comet between 1906 and 1913, now calculated by Mr. J. Polak, are very large, and explain the failure to find the comet in 1913 and 1919. It is due again at perihelion in March 1928. Search ephemerides for next autumn, using Polak's elements, are given in *B.A.A. Handbook*, 1927.

Ensor's comet 1926 III. is not included in the table of elements, since the orbit given in the last Report is probably as near the truth as any at present to hand. The comet was so large, diffused, and irregular in shape in 1926 March and April, that there is considerable doubt as to which point should be taken as the centre of gravity.

In Nos. 566, 569, 570, and Neujmin the values of T and Period given in the table have been corrected by the recent observations. The original values of T were January 23.466, August 7.2, December 7.91, January 12.648 respectively.

Two further corrections to the Sequel to Galle's *Cometenbahnen* may be noted.

No. 488 Halley. The last photograph was 1911 June 1, not July.

Nos. 546, 547. The numeral II. should be deleted from No. 546 since it is very doubtful whether Nakamura's object is identical with Perrine's comet. If not, its date of perihelion is indeterminable. No. 547 should therefore be numbered 1922 II., not 1922 III.

A. C. D. C.

Solar Activity in 1926.

Sun-spots.—Sun-spots have been very numerous during the year, the mean daily spotted area being about 50 per cent. greater than that for 1925. Twelve naked-eye groups of spots were seen, their dates of central meridian passage and latitude being as follows :—

Jan. 22	21° S.	June 22	25° N.
„ 24	21° N.	„ 29	21° N.
Feb. 15	18° S.	July 30	10° S.
„ 19	21° S.	Aug. 16	18° S.
Mar. 4	26° S.	Sept. 20	24° N.
May 14	20° S.	Dec. 16	7° N.

The great spot of January 24 was the largest so far photographed at Greenwich. Its average area during the transit was over 3000 millionths of the sun's hemisphere. It will be seen from the table above that during the latter half of the year large spots appeared within a wide range of latitude. This may be taken as an indication that the sun is nearing maximum phase of activity for the present cycle. The average latitude, approximately 17°, for the year's spots and faculæ suggest, however, that the peak will not be reached for about a year and that it will be a high one.

H. W. N.

The Prominences.—The mean daily areas in square minutes of arc derived from the Kodaikānal photographic records are as follows :—

	North.	South.	Total.
1926 January to June . . .	4.66	3.52	8.18
July to December . . .	4.40	3.26	7.66

The mean daily numbers were 18.2 and 18.1 for the first and second half-years respectively.

Areas show an increase of 31 per cent. above the previous year.

The maximum of prominence activity in high latitudes has advanced about 10° towards the poles compared with the year 1925. The eastern hemisphere showed an excess over the western in prominence numbers, but a defect in prominence areas.

As regards the special features of the sun which are observed visually in the spectroscope, the solar activity has increased very much this year as compared with previous years. Prominences exhibiting metallic lines numbered 152, compared with 50 in 1925. All occurred in latitudes below 50° , and 99 of them were in the northern hemisphere. The number of hydrogen displacements in the chromosphere was 650, as against 546 in 1925. Of these 374 were towards the red, 257 towards the violet, and 19 both ways simultaneously. Bright reversals of the H_α line in the neighbourhood of sun-spots numbered 705, nearly twice as many as in 1925, while the number of H_α displacements on the disc was 217, twice as many as in 1925. Of these displacements 159 were towards the red, 50 towards the violet, and 8 both ways simultaneously. D_3 was observed as a dark line on 456 occasions, or nearly 3 times as often as in 1925.

The mean daily area of prominences projected on the disc as absorption markings was nearly double that of the previous year. On the whole there was an excess in the western hemisphere in both areas and numbers. The largest dark marking ever photographed at Kodaikānal was observed on 1926 February 21; this dark marking was of long duration, being first seen on 1925 December 18, and last seen on 1926 April 16.

T. R.

Solar Research in 1926.

Solar Radiation.—By means of light filters consisting of thin films of silver or gold on quartz plates and lenses, E. Pettit (1) has investigated the ultra-violet radiation of the sun and its variations. He used a thermocouple to measure the intensity, and finds that during the past year and a half there has been an increase of about 80 per cent. in the radiation between 3100 and 3200 A.U. The large variations found by Dobson in a similar investigation are not confirmed and are attributed to the effect of atmospheric haze.

The reality of a variation of the solar radiation is maintained by C. G. Abbot (2) in a new discussion and further analysis of the Mount Wilson pyroheliometric observations from 1910 to 1920. To avoid the objections raised by certain critics, *e.g.* Kimball, only observations taken at the same time of the year are used in the discussion, thus the

effect of annual variations and varying distance is eliminated. He uses a special grouping of days, and weighted mean values of the annual percentage departure from the average for each group are found to give agreement with the results of the bolometric measurements.

H. H. Clayton (3) has continued his work on Solar Activity and Long-range Weather Forecasting, and C. F. Marvin and H. H. Kimball (4) in criticising the results conclude that, firstly, the existence of a variation in the solar radiation is not yet definitely established, and secondly, that the forecasts derived by Clayton using data of the solar constant do not show any markedly greater accuracy than those obtained in the usual way, using temperature distribution data.

Magnetism.—In a reply to Abbot's criticism of his investigations, C. Chree (5) points out that his object was to examine into the 27-day interval and the relation between the daily values of the solar constant and the daily magnetic character number, partly to convince himself of the significance of the second if it should show the 27-day period to be expected.

Sun-spots, Faculae, and Prominences.—By considering horizontal vortices just above or just below the photospheric layer, V. Bjerknes (7) (34) has developed a theory which accounts for the lowered temperature in a spot, analogous it is seen with the low temperature in terrestrial cyclones, and for locally superheated regions of the photosphere, which are due to a sub-photospheric vortex having an opposite motion and a hot nucleus.

In a development of his views on the movements of Sun-spots, Faculae, and Flocculi (summarised here last year), R. Sekiguchi (8) points out that in early stages spots lying in low latitudes tend to move towards the equator. The asymmetry in the spot motions can be removed, he finds, by considering separately spots in an early or late stage of development.

Corona.—The problem of the theory and measurement of the continuous spectrum of the corona has received attention from several workers. J. Woltjer, jun. (18), has shown that, on the hypothesis of an electron-gas constitution of the corona, an excess of infra-red light is scattered, but it is found on further investigation that this excess is only scattered in directions which, if prolonged backwards, would meet the body of the sun. Consequently, since such directions in the corona are not those in which we look when observing it, no excess of red radiation is to be expected in the observed coronal radiation. E. Pettit and S. B. Nicholson (19), in discussing experimental determinations from water-cell transmissions at the eclipse of 1925 January 24, find that no difference can be detected between the solar and coronal distributions of spectral intensity. They repeat Woltjer's first estimates of the reddening with refinements and find an enhanced effect, but still too small to be detected by the methods used, being unaware of the directional effect subsequently found by him. Observation then, so far as it goes, may be said to support the electron-gas theory according to this new view.

W. Anderson (20), however, in his investigations supposes that the continuous spectrum of the corona is different from that of the sun, and by showing that it is impossible for such a distribution to be scattered by an ordinary gas, derives indirect evidence for his electron-gas theory of its constitution.

F. Slocum (21), in describing the observations of the 1925 corona at Van Vleck Observatory, states that a corona of intermediate type was found, having equatorial wings and polar rays characteristic of a minimum sun-spot period, but there was a perfect dome typical of a maximum period. Photographs and a sketch are reproduced in his article.

Spectroscopic Work.—C. E. Moore and H. N. Russell (22) attribute the widening of the winged lines in the solar spectrum in the main to the higher abundance of the elements concerned in the sun, and consider the effect is uncorrelated with widening as observed in the laboratory. All the lines concerned arise in low energy levels of the atoms, those arising from the lowest levels being the most widened. Strong components of multiplets are more widened than are weak ones. They give tables of the lines investigated and their spectral classification; ionised calcium provides the extreme example in H and K: eleven elements account for the 138 most conspicuous lines, of which 89 are due to iron.

C. E. St. John (23) has contributed a discussion of the separation of the three main causes producing differences between solar and terrestrial wave-lengths.

The recent classification of some of the multiplets in the spectrum of ionised vanadium has enabled several of the multiplets to be identified in the solar spectrum (24), some of them not having been previously identified.

Eclipses.—At a joint meeting of the Royal Society and the Royal Astronomical Society, a preliminary account was given of the results obtained by the British Expedition to Sumatra (26) to observe the total eclipse of 1926 January 14. Weather conditions were favourable, and excellent photographs were obtained. A good record of the flash spectrum in the ultra-violet was obtained, extending to a wave-length of 3066 A.U. The heights in the chromosphere accord with previous results. The most interesting part of the report dealt with the results and possibilities of the photometric measurements on the flash spectrum. Intensity measurements were made of the lines, general continuous radiation, and the hydrogen continuous emission beyond the limit of the Balmer series, and modern physical theories were invoked to derive temperatures in different regions of the chromosphere. The results quoted were very different according to the data and theory employed to reduce the observations, but while they indicate the need of caution and further investigation, they also show the importance and wide possibilities of the new field of observation. The attempted photometric observations on the red $^2\text{P}-^2\text{O}$ lines of Ca^+ failed on account of the insensitivity of the plates in that region, the dyes employed, moreover, were not suited to the tropical conditions. The intensity variations of the K line over a range of 10,000 to 30,000 km. were found to be in good

accord with Milne's theory developed by Taylor to give the observable distribution. It is of interest to note that the photometric reductions were rendered possible only by aid of the recent work of Ornstein, Burgers, Dorgelo, Kronig, and others, on the theoretical intensity ratios of the components of multiplets, since the density scale impressed on the plates was a time-variation scale, and could only thus be converted to an intensity scale.

The results of the Swarthmore Expedition to Sumatra in 1926 are described by J. A. Miller (28). Photographs of the corona were obtained, and reproductions are shown, photometric determinations were also made on the corona, and good plates were obtained for the test of the Einstein theory.

An account of the U.S. Naval Observatory Expedition to Sumatra, with photographs of the corona, is published by F. B. Littel (29).

Theoretical.—V. Bjerknæs (34) (7) has contributed an important theory of the hydrodynamics of the sun, which explains in outline all the prominent features of sun-spots and their behaviour, namely, the lowered temperature in spots, their bi-polar structure, their magnetic polarity and its reversal in successive cycles, the tendency of spots to appear in lower latitudes as each cycle progresses, and the occurrence of cycles. His theory, it is pointed out by Greaves and Newton (34), also explains the fact, found at Greenwich from analysis of the photo-heliograms, that the faculæ, which are at a higher level than the spots, are moving continuously away from the equator.

Bjerknæs, using established hydrodynamical principles, develops a general scheme of the system of circulation in the upper layers of such a body as the sun. Sun-spots are regarded as vortices, and the associated magnetic field is reversed by the reversal of the vortical motion. A vortical motion in which the horizontal curved current has an upward increasing intensity has a cold core and raises gas up from the interior cooling it adiabatically (*vide* note on Sun-spots). He suggests that all spots of the same cycle belong to a single vortex ring normally situated below the surface of the photosphere, which, by breaking through in places, produces spots. Equatorward movements are supposed due to a general circulation from pole to equator in the upper layers of the photospheric surface, the possibility of which is investigated.

E. A. Milne (35) has made a detailed examination of the mechanism whereby an atom in the chromosphere can be accelerated out of its absorption line by radiation-pressure. If the intensity minimum in a line is flat, it is found that there is no general motion of the atmosphere, and atoms moving with a small inward or outward velocity can be brought to rest. The theory is applied to the study of prominences, and explains Pettit's observations of their accelerated motion more accurately than Sur's theory. The asymmetry in the motions of the atoms is regarded as a possible explanation of the red displacement of the high-level lines in the chromospheric spectrum.

The theory of Sur (36), to which we have just alluded, is an attempt to explain the motions of eruptive prominences as due to an accelerating force caused by radiation-pressure in excess of that necessary for equi-

librium, and coming from a locally superheated region of the photosphere below the prominence.

An explanation of the motion of the vapours in the solar atmosphere above a sun-spot (as shown by Evershed and St. John) in horizontal planes has been given by S. R. Pike (37). The motion is due to diffusion from the outer regions into a low-pressure region immediately above the spot, where the lower radiation from the spot allows a correspondingly low pressure to occur.

In considering the radiative equilibrium in the upper layers of the sun, P. Parchomenko (38) finds an expression for the difference between emission and absorption, which he shows must exist except at certain discrete points. Since in the outer layers no release of sub-atomic energy takes place, there must be convection currents there, and consequently the emission at the surface is stronger than the absorption. The theory is tested numerically, and the distribution of intensity over the disc is worked out and found to agree well with observation.

Assuming that the stream of radiation from the sun's interior is modified in spots by convection currents, S. Rosseland (39) develops a theory to derive a simple formula connecting the mean density, vertical velocity, and mean vertical thickness of a spot. Reasonable values of the size, motion, and temperature in spots are obtained. The theory of solar rotation is also discussed and the influence of the manner of generation of energy in the sun on the internal motions of the matter composing it considered.

V. Ambarzumian and N. Kosirev (40) discuss the constitution of the visible solar surface, and propose a method of determining the heights of faculæ from their variations in brightness. They also discuss the relation between optical depth and the temperature in the outer layers of the sun.

Miscellaneous.—C. G. Abbot (42), in reply to the criticism of his measurements of the distribution of energy over the sun's disc by Moll, Burger, and van der Bilt, claims that, while it is shown that errors in the Smithsonian absolute values exist, of the sign claimed by the Dutch authors, they do not exceed 0.3 per cent. at either 95 or 92 per cent. out along the solar radius.

Attention has been drawn by G. E. Hale (43) to some new possibilities in solar research, with special reference to the possibilities of the spectrohelioscope. In his article a description of the equipment at Mount Wilson is given, and also a review of the results obtained with the different instruments.

Observations of the diameter of the sun at Greenwich (45) show that the most marked features are a variation with the time of the year, and an extreme range amounting to 1" of arc. The observed diameter is found to be greater in summer than in winter, and irradiation is regarded as the most probable explanation of the effects found.

G. Abetti (46), in a discussion of the observations at Arcetri, Catania, and Madrid, in 1921-25, finds that the height of the chromosphere is greater toward the poles, and that it rose from 1921 to 1922 and has since been falling.

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Stellar Spectroscopy in 1926.

Novæ.—(See note on Variable Stars.)

Photometry and Spectrophotometry.—C. H. Payne and H. Shapley (5) have made an attack on the investigation of the distribution of intensity in stellar absorption lines. Their method is to obtain a series of graduated exposures by stopping down the aperture of a telescope used with an objective prism, and to measure the spectra with a Moll recording microphotometer. The effects of overlapping lines are not eliminated in their work in some cases, but the results are of great interest, and they find that the intensity in a line (ratio of light in the line to that which the continuous spectrum would emit over the same range) is as much as 25 per cent. for quite strong lines, *e.g.* H and K. Y. Öhman (4) has investigated the suitability of short stellar spectra for microphotometric work. J. Hopman (2) has reviewed the methods used to determine surface temperatures of stars, and has summarised critically the results obtained so far.

A. F. and F. A. Lindemann (3) advocate the use of a photo-electric photometer with suitable nearly monochromatic colour-filters for stellar photometry. In a description of the apparatus and the method of using it, they suggest the use of three filters, transparent each in a fairly narrow band (in the red, green, and violet), which give nearly the same deflection in conjunction with a potassium photo-electric cell when used to screen sunlight, and thus it is possible to tell at once from the deflections of the electrometer whether a star is at a higher or a lower temperature than the Sun.

Spectroscopic Binaries.—In an investigation of the mass ratio of spectroscopic binaries, O. Struve (15) finds that, on account of the absence of systematic order in the mass function of spectroscopic double stars with P greater than three days, the secular decrease of mass cannot be invoked to explain the small mass ratio of stars with small period. Probably the observed decrease in mass ratio of a group of stars is to be accounted for by the supposition that they are Cepheids and not true binaries. He confirms the previously found small mean value of mass ratio for spectroscopic binaries.

The same writer, in a paper (14) on the orbit of $37\phi^1$ Orionis, finds that the H and K lines show oscillations of the same period as the star, but they cannot be accounted for by the blending of a stationary line and a stellar line. Possibly the motion is due to "whirls" in a calcium cloud caused by the motion of the binary through it.

Spectroscopic Parallaxes.—An ingenious and important new method of deriving spectroscopic magnitudes has been developed by Ch'ing-Sung Yü (22), in connection with his investigations on the continuous hydrogen absorption spectrum. This spectrum is produced by the ionisation of hydrogen atoms, and its intensity consequently depends on the fraction of atoms remaining un-ionised. Yü finds empirically that it is a function of colour temperature and absolute magnitude. By photometric measures he determines the colour temperature and the

hydrogen absorption from the same spectrum, and from these two quantities infers the absolute magnitude. Thus we have a method applicable to the A-type stars which is free from the objection to the method of Adams and Joy, whereby different reduction curves are used for stars of different types. S. A. Mitchell (21) has compared Yü's spectroscopic parallaxes (and some Mount Wilson ones) with trigonometric values measured at the Leander McCormick Observatory. He finds that the accidental differences are larger in the values of Yü than in those of Mount Wilson, and that the systematic differences are much too large to be overlooked. The weakness of the new method is its requirement of a rather accurate determination of the temperature of the star, to errors in which the method is sensitive.

A. V. Douglas (17), in a study of the spectroscopic magnitudes of A-type stars, shows that seven criteria have been found, by which absolute magnitude and parallax may be determined. These criteria include both the widths and the relative intensities of the lines. The parallaxes so obtained, when compared with trigonometric values from Mount Wilson and Arcetri, show that a greater individual accuracy can be obtained by the use of such criteria than by adopting a statistical mean magnitude for each spectral subdivision.

B. Lindblad (20) has applied criteria developed by him to a large number of stars in a certain region of the Greenwich polar zone down to photographic magnitude just less than 9.0, and to other stars with well-known proper motions scattered over a wider portion of the sky.

In an analysis of the data known and of the methods of deriving masses of stars, B. P. Gerasimovic (18) develops a new formula, and shows that comparison of spectroscopic and trigonometric parallaxes forms a good basis for the determination of stellar masses.

O. J. Lee (19) finds a trigonometric parallax for the hydrogen envelope star B.D. + 30° 3639, giving a distance of 1125 light years, and a diameter of the envelope of twenty-eight times the distance across the solar system.

W. S. Adams, A. H. Joy, and M. L. Humason (16) have determined the absolute magnitudes and parallaxes of 410 stars of type M. Of these, 28 are brighter than magnitude -1.0 (super giants). The ordinary giants show very little dispersion, while the dwarfs vary with advancing type from magnitude $+7.0$ to $+12.5$.

Theory of Spectra and High-Temperature Ionisation.—The spectra of giant stars indicate an increased intensity of the enhanced lines, even of those for which the maximum intensity occurs at a much lower temperature in the spectral series. This is shown by H. N. Russell (25) to be caused by the much lower electron pressure in a giant star than in a dwarf. Consequently, for elements having an ionisation potential less than a certain limit, I_0 say, the ionisation is greater in the giant than in the dwarf, for elements with greater ionisation potentials the reverse is true. If, however, I_0 lies between the first and second ionisation potentials of any element, then the first ionisation is encouraged and the second repressed in a giant.

A. Pannekoek (24) derives an ionisation formula for atmospheres not in thermodynamic equilibrium, by identifying the formulæ, obtained by the use of probability factors for the atomic states and transitions, with the Saha formula for isotropic radiation, *i.e.* a particular case. He claims that this determination of the probability factors must hold good always, since they are atomic properties and are not influenced by the external statistical conditions such as pressure and temperature. B. Gerasimovic (23) contends that this formula is in error, firstly, because he does not admit Pannekoek's extension of the use of the equation of statistical equilibrium to a state when the radiation is not isotropic, and secondly, the law of recombination of ions used by him is incorrect.

Classification.—J. S. Plaskett (37) has called attention to the peculiarities in the spectra of three stars (*v* Sagittarii, HD 45910, HD 50820). Each of these stars has really two spectra. In each there is a fundamental unchanged spectrum of type B2 or B3, with a variable many lined A2-type spectrum superposed upon it. The hydrogen lines have several components varying in strength, but not in relative position: therefore they are not from a companion rotating around a primary, but are like the components of the lines in Novæ, or like γ Cassiopeiæ. It will be of great interest to obtain details of the distribution of the continuous spectrum in these stars. Plaskett disagrees with the interpretation of *v* Sagittarii (deduced by Ludendorff from Miss Maury's observations) as a very massive binary, since the spectrum cannot be so explained.

G. Shajn (38) remarks that in stars having composite spectra the cause may lie in peculiar atmospheric conditions, or in the binary character of the star. If it is the latter, there should be certain analogies with the other binary stars. Assuming this to be true, the distances of 259 stars have been computed. The parallaxes are very small, and the stars are strongly concentrated to the middle plane of the Milky Way.

P. W. Merrill (34) has discussed the behaviour of lines of various elements (H, He, Li, Na, K, Mg, Ca, Sr, Ba, Al, Ti, V, Cr, Mn, and Fe) in stellar spectra of classes M, N, and S, paying special attention to the series classification of the lines and their relative intensities in the various spectral types.

F. E. Baxandall (29) finds that in the banded portion of the spectra of G, K, and M types, the lines showing considerable increase in intensity in passing from G_0 to K_0 are those of Fe, V, Cr, and Ti: Ba and Sc also strengthen. The lines that show weakening include some Fe lines and some hydrocarbon lines.

In a study of the spectrum of α Cygni between wave-lengths 3020 and 3000, W. H. Wright and D. Applegate (41) succeeded in reaching this remarkably low wave-length by using the spectrograph without a mirror, and thereby avoiding the loss on reflection by silver in this region.

W. J. S. Lockyer (33) has continued his study of the spectrum of ϕ Persei, and has published a detailed account of its features throughout a complete cycle (1925–26).

A detailed discussion and description of 131 spectrograms of Mira

Ceti, taken with the 60-inch and 100-inch reflectors at Mount Wilson during the last ten years, has been published by A. H. Joy (31), who briefly discusses the problem of the variation of Mira and similar variables.

Theoretical and Special Investigations.—An atom receding from the Sun has, when in its immediate neighbourhood, a rapidly increasing acceleration, which ultimately falls off, and the atom reaches limiting velocity, since the intensity of the radiation falls off as the inverse square of the distance. According to Milne (48) this limiting velocity turns out to be of the order of magnitude of the velocity displacements observed in Novæ. He suggests that these particles may be the cause of auroræ, and finds that, if they are ionised calcium atoms, they would, if coming from the Sun, penetrate our atmosphere to about the observed height of the lower level of the auroræ.

M. C. Johnson (47) has investigated the velocity of ions under the influence of radiation-pressure in a stellar atmosphere, and finds that equilibrium breaks down only when the effective temperature of the star exceeds $25,000^{\circ}$. Electron captures made by hydrogen and the form of the resulting continuous spectrum are considered by him.

In considering the origin of bright lines in stellar spectra, S. Rosse-land (50) points out that a star in hydrostatic and radiative equilibrium shows absorption lines over the disc, and emission lines from the atmosphere beyond the disc. This equilibrium state is only reached if the pressure and temperature exceed certain limits; below these, *i.e.* in the outer parts of stellar atmospheres, fluorescence comes into play and this will show all over the disc. This may account for bright lines in early-type stars. Other causes probably operating, and which will cause bright lines in late-type stars, where the above do not operate, are penetrating radiation, or a state of the atmosphere far removed from hydrostatic equilibrium, allowing therefore local high temperatures and hence bright lines.

S. Albrecht (44) makes a criticism of the attempt of St. John and Adams to explain the K term as due to convection currents. In an analysis of the various factors contributing to the K term in the B stars, he draws special attention to systematic errors in the standard wavelengths used to reduce the plates, and finds this reduces K from $+4.0$ to $+2.6$ km./sec. For this to be due to the relativity displacement the average mass must be about twenty-five times that of the Sun, and the density about 0.1, or else ten times the Sun's mass and a density of 0.6. Either of these is possible, but the most probable value, based on the accepted average mass and density, of the displacement is $+1.4$ km./sec.; thus general downward convection currents may be the cause of $+1.2$ km./sec.

Statistical Investigations.—In investigating the relations between the distribution of the stars in space and the mean colour-index or spectrum, G. Shajn (53) finds, among other results, that the proportion of late-type giants in the remote portions of space, as well as in our own neighbourhood, is small. For the faintest stars the accepted mean C.I. should be increased. He points out that the predominance of late-type

spectra among the faint stars does not mean that the proportion of late-type stars increases with distance.

The correlation between C.I. and spectral type for the B- and A-type stars is shown by recent work to be incomplete, and O. Struve (56) finds that the observed dispersion cannot be accounted for by errors of observation. A systematic reddening effect in certain areas, which he finds on the basis of Bottlinger's colour-indices, may be due to the scattering of light by dark nebulae or by calcium clouds; we would, however, with regard to the possibilities of the production of detectable reddening by scattering, draw attention to Eddington's Bakerian lecture in 1925 (67). Wolf found no such effect in the dark region of Cygnus, and Struve makes an attempt to reconcile this result with his own.

B. Gerasimovic (52) has made a study of the luminosities of the stars in which the lines of ionised silicon and of ionised strontium are abnormally strong.

Wave-Lengths.—H. N. Russell (58) has published a classification of the multiplets of the quartet and sextet systems in the spectrum of FeII (ionised iron), in which 214 lines are arranged in 35 multiplets involving 16 terms. He finds that the lowest term is the sextet D term and the next the quartet F' term. The doublet spectrum is not yet unravelled, and includes many lines.

B. T. Barnes (57) has made interferometer measurements of the pressure shift of lines in the arc spectrum of nickel, and finds that most of lines show a displacement of less than 0.005 A.U., per atmosphere.

Miscellaneous.—A correction to the radial velocity of the companion to Sirius increases it from +1.7 to +4.3 km./sec., and so the shift detected by Adams and attributed to relativity displacement becomes +19 km./sec.

In his Bakerian lecture Eddington (67) discusses diffuse matter in interstellar space, and arrives at the conclusion that it cannot cause appreciable reddening or general absorption, but that it may provide the agent responsible for the "fixed" calcium lines. The fact that they are only observed in bright early-type stars is due to the fact that they are the only ones sufficiently distant that we can detect and that have a sufficient thickness of absorbing matter in the line of sight, and also that in later types the detection is rendered difficult or impossible by the presence of other lines in the star's own spectrum. While the density of radiation in interstellar space is so small that a black body, if exposed to it, would only acquire a temperature of about 3° absolute, yet its spectral distribution is far from that of black-body radiation of this temperature, since it is merely diluted star radiation, which has for the most part a spectral distribution corresponding to a few thousand degrees. Thus any agent capable of responding to one particular range of wave-lengths only, will acquire a temperature corresponding to the wave-lengths involved, and this may be as much as 10,000°. Calcium, it is found, will be for the most part doubly ionised under these conditions and sodium once ionised, and so the simultaneous occurrence of H and K of calcium and the D lines of sodium receives an explanation.

C. H. Payne and M. Howe (70) find that the number of lines of the Balmer series observable in stars of class A is greatest for the stars of the highest luminosity, and suggest that the number of lines produced is related to the mutual distance of the atoms in the absorbing layers, and hence a method of deriving the pressures in these layers is afforded.

R. H. Curtiss (66) describes the different velocity curves that are obtained for W Sagittarii from lines of different chromospheric heights in the Sun, and presumably also in the star.

C. H. Payne (69) has found that astrophysical evidence favours the assignment of the lowest level in the spectrum of FeI to a quintet D term, as has been established on spectroscopic grounds by Laporte and others.

W. S. Adams and C. E. St. John (65) have made an interesting attempt to detect water vapour and oxygen lines in the spectrum of Mars, by using the registering microphotometer to measure the displacement and intensity changes in the telluric lines consequent upon the fact that since Mars in moving in the line of sight these lines will be slightly displaced if they occur in the spectrum of Mars. They express their results in the picturesque form that "Area for area Mars has 3 per cent. of the water vapour over Pasadena, and two-thirds of the oxygen above Mt. Everest in its atmosphere."

Mention must also be made of Professor Eddington's (74) treatise on the Constitution of the Stars. This is a most valuable collection of the researches, of which his own form so great a part, on the theory of stellar interiors and atmospheres, in a systematic form. The ground covered includes the study of radiative equilibrium, the mass-luminosity relation, variable stars, the problem of the stellar absorption coefficient, the source of stellar energy, stellar atmospheres, and diffuse matter in interstellar space.

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Double Stars.

Measures and New Pairs.—The first volume of the *Annals of Dearborn Observatory* contained the double-star observations of Professor Fox up to 1913. Vol. ii., which has now been published, is very similar in form to vol. i. and contains later measures. Professor Fox has been in the habit of observing special lists of stars besides the usual miscellaneous lists of stars of interest. Thus the first of his volumes contains measures of all the Holden and Küstner double stars, while the new volume contains measures of all the stars discovered by Burnham with the Dearborn telescope in the years 1874–1880. The new double stars Fox 53–102 are included in this volume, which contains in all about 6000 observations relating to 1100 systems. In accordance with a resolution of the I.A.U., the positions of the stars are given for the epoch 1950. Another useful feature is the B.D. number of all the stars. The introduction gives the hypothetical parallaxes of 28 double stars and the relative proper motions, deduced from micrometrical measures of 40 stars.

Mention should be made here of double-star measures which have been regularly printed in the *Journal des Observateurs* since its foundation in 1917. During the past two years the measures of double stars made by Mme. E. Chandon with the 12-inch refractor of the Paris Observatory in 1920–21 have been published. The various lists contain about 2000 measures of 700 double stars. The same journal contains the measures of over 300 double stars by E. Pologne with the 30-inch Nice refractor. P. Gauchet has also published in this journal the measures of three series of photographs of double stars taken at the Zo-Sè Observatory. The first series contains 28 Σ stars with a mean separation of 5", with the smallest less than 3". The other series contains 120 wider pairs.

Last year we reported that Dr. van den Bos of Leiden had proceeded to the Union Observatory, Johannesburg, to assist in the double-star work with the new 26-inch visual refractor. In *B.A.N.*, 107, he de-

scribes the work being done with this telescope. On nights when the definition is not at its best the known southern double stars are being remeasured. On other nights a systematic search for new double stars is being carried out. The C.P.D. is taken as a basis, and all stars given as magnitude 9.0 or brighter either in the C.P.D. or in Gould's catalogue are examined. The zone -19° to -37° is being observed by Dr. van den Bos, -38° to -51° by Dr. Innes, and -52° to -90° by Mr. Finsen. It is expected that the search will be finished in a few years. In *B.A.N.*, 107, 111, 114, Dr. van den Bos gives the positions and details of the new double stars found by himself, viz., B 3 to B 634.

In *A.J.*, 36, 155, and *A.J.*, 37, 57, Mr. S. G. Barton publishes the results of his examination of the Astrographic Catalogue for double stars. The first paper deals with the Oxford Zone from $+25^{\circ}$ to $+30^{\circ}$. It gives results for 145 stars of the β .G.C., 24 of the J.G.C., and 5 other previously known stars. Many of them are wide and have been included only because the proper motion is known. There are also given 62 faint double stars, mostly with the separation less than $5''$, not previously catalogued. The second paper deals similarly with the Helsingfors Zone, $+39^{\circ}$ to $+47^{\circ}$, so far as it is published. It gives results for 87 stars of the β .G.C., 25 of the J.G.C., 6 Espin stars, 53 new double stars, and other 20 suspected doubles.

Other measures of double stars published in various periodicals are indicated by the following table:—

Author.	Reference.	No. of Stars.	Selection.
Berman, L.	<i>A.J.</i> , 36, 115	100	Misc.
Doberck, W.	<i>A.N.</i> , 228, 401	141	„
Espin, T. E., and Milburn, W.	<i>M.N.</i> , 86, 131	53	Mostly E and M.
		72	New E.
		64	New M.
Luplau-Janssen, C.	<i>A.N.</i> , 227, 43	17	Misc.
„	<i>A.N.</i> , 229, 91	36	„
Nissen, A.	<i>A.N.</i> , 228, 87	6	„
Peek, B. M.	<i>M.N.</i> , 87, 171	44	Σ
Zo-Sè Observatory	<i>A.J.</i> , 37, 47	93	Misc.

The lists of Luplau-Janssen and others at Urania Observatory contain many observations of ξ Ursæ Majoris.

Orbits.—In *B.A.N.*, 101, Dr. van den Bos has given the elements and various constants for the computation of ephemerides of 118 double-star systems. Generally the most recent set of elements has been given, but sometimes more than one set is given. In *Union Obs. Circ.*, 68, he has discussed different systems of elements of binary stars and the effect of the motion of a binary in space on the elements. Notes on the determination of orbits, generally by graphical methods, have been given by K. Laves in *A.N.*, 227, 321, and *A.J.*, 37, 1; by B. Meyermann

in *A.N.*, 228, 49; and by B. H. Dawson, *A.J.*, 36, 181. The following new orbits have been published:—

	P.	a.	e.	
Σ 2912	136 years	0.72	0.53	Van den Bos, <i>B.A.N.</i> , 98.
40 Eridani BC	248 "	6.89	0.40	" "
β 1212	71 "	0.66	0.89	G. P. Kuiper, <i>B.A.N.</i> , 100.
α Centauri	80 "	17.75	0.52	<i>Union Obs. Circ.</i> , 68.

B. H. Dawson has published provisional orbits of *h* 5014 in *A.J.*, 36, 181, with periods ranging from 154 to 214 years; *a* from 1".11 to 1".21, and *e* from 0.48 to 0.52.

Miscellaneous.—In the *Publications of Pulkowa Observatory*, 10, part 2, Dr. Shajn discusses his measures of the colours of double stars observed by the method of exposure ratios. In a table he gives the colour index of both components of 123 systems. The division of stars into giants and dwarfs is shown by a Russell diagram. The relations between colour and spectrum, colour and absolute magnitude, and the masses are considered. The masses are deduced both from Seares' diagram based on the principle of the equipartition of energy and Eddington's mass-luminosity law. It is found (1) that Eddington's masses of the stars of very high luminosity and late spectral type are larger than Seares', (2) the opposite holds for stars of high luminosity and early type, (3) the results agree closely for dwarfs.

In *A.N.*, 228, 337, Dr. Shajn draws attention to stars of composite spectra in the Henry Draper Catalogue and urges further observation of them.

In *A.J.*, 36, 177, Maude Bennot gives the relative motion of 40 pairs of stars deduced from micrometrical observations.

Catalogues.—Dr. Innes, who brought out a Reference Catalogue for Southern Double Stars in 1899, is bringing out a new general catalogue for stars south of -19° Dec. It is in the form of a loose-leaf catalogue and is being issued in hourly sections as it is ready. Already the sections from 0^h–4^h and 16^h–17^h have been distributed. The loose-leaf system has several advantages, especially in speed of publication and ease of replacing sheets. It prevents the use of a new serial number. For each star there is given the name or symbol of the discoverer with a number, the number in the C.P.D., or other suitable name, Harvard magnitudes, spectral type and colours where available, the positions for 1900 and 1950, and the measures. The increase in this catalogue as compared with the original reference catalogue can be gauged from the first hour of R.A. Of the original 65 stars 23 are excluded, mostly because they are north of Dec. -19° , while 141 new pairs are included. The number of measures for the stars which have been retained is about doubled. The catalogue was prepared by Dr. Innes, and has been examined by Dr. Van den Bos and Mr. B. H. Dawson.

Dr. Aitken is preparing an extension of Burnham's General Catalogue and has asked for copies of all measures up to March 1 of this year.

Variable Stars.

The usual large number of observations of variables, discoveries of new ones, and calculations of elements of variation have been made during the year, accounts of which will be found scattered throughout various publications: *Journ. B.A.A.*, *Harv. Bull.*, *Pop. Ast.*, *Lyons Obs. Bull.*, and *Ast. Nach.* may be mentioned in particular. In addition to this routine type of investigation there has been an exceptionally large amount of work of a special character. This appears to be due mainly to three causes—the possibility of empirical generalisations arising from the accumulation of data, the stimulus of recent theoretical work, and the widening of the scope of inquiry made possible by improvements in the methods of observation.

An interesting example of the influence of the last-named factor will be found in a preliminary paper by R. H. Baker (*P.A.S.P.*, **38**, 86), in which are described the characteristics of a (at present) small class of variable stars of very small range—the class referred to by Henroteau (see *M.N.*, **86**, 256) as the β Canis Majoris type—the detection and study of which became possible with the application of the photo-electric cell to stellar photometry. As an example of the variations now capable of measurement, a series of photometric observations of ν Eridani is plotted, showing an unmistakable periodic variation of 0.08 mag. (about 8 per cent. extreme variation). The ranges of brightness for the other members of the class are of the same order. The periods of the stars are regular, and of the order of 0.15 day. The spectrum lines oscillate in the periods of the light variations, with accompanying changes of intensity, but the amplitudes and shapes of the velocity curves do not remain the same, the mean velocities varying periodically. The shapes of the light curves also change, but the intervals from minimum to maximum do not depart markedly from half the periods. Seven stars are at present known having these characteristics (viz. ν Eridani, γ Bootis, ζ Ursæ Min., β Cephei, 12 Lacertæ, α Ursæ Min., α^2 Canum Ven.), but others are suspected, and there are in addition seven stars (δ Ceti, γ Ursæ Min., σ Scorpii, θ Ophiuchi, γ Lyræ, δ Aquilæ, τ Cygni) with similar spectroscopic variation but constant light. β Canis Majoris also appears to be of the latter type. It will be remembered that Henroteau classified all stars of the character here considered jointly as Cepheids.

In the concluding paragraph of his paper, Baker refers to another type of light variation found by Stebbins (see *Science*, **62**, 519, 1925) and others, whose reality is beyond doubt. It consists of irregular light variations, occurring in stars of all colours but increasing in amount with the redness of the stars, and found in some cases to be progressive. Thus, β Aquilæ (red) is found to undergo a progressive change of 0.05 mag. in 100 days, and the difference of brightness of δ and γ Ceti (both white) changes similarly by 0.02 mag. in two months.

A method of obtaining accurate estimates of the magnitudes of variable stars without the use of a photometer is described by G. D. Reynolds in *Journ. B.A.A.*, **36**, 247.

It will be convenient to classify the bulk of the investigations

referred to in this note under the usual headings. Two publications, however, of a general character can more appropriately be mentioned separately. "The Internal Constitution of the Stars," by A. S. Eddington (*Camb. Univ. Press*, 1926) contains a chapter on variable stars in which the pulsation theory of Cepheids, the possibility of explaining long-period variation by pulsations, and reflection effects and other characteristics of eclipsing variables are discussed. A summary cannot profitably be given, but the new matter dealing with eclipsing variables is summarised below from the original publication.

Secondly, A. V. Nielsen (*A.N.*, 5436) attempts to relate different classes of variable stars—divided broadly into short-period (including Cepheids and cluster variables) and long-period (including Mira type and variables of spectral classes M, K, N, R, S) variables—in a wide generalisation. It is maintained that these stars differ from one another only in their stage of development and the region of space in which they originated. Evidence of this is drawn from the relations between their spectra, periods, amplitudes, etc., and the existence of stars showing characteristics of transition between the various types. Arising out of the discussion the following course of evolution is suggested for stars in general. The original state is that of Mira at its minimum (absolute magnitude about +5, much fainter than that of a giant star), which changes to that of a typical Mira variable as a step towards the giant condition. As time goes on the period and amplitude decrease, and the absolute brightness at minimum slowly increases. The next stage is represented among natives of our own galactic system by Cepheids and variable N-type stars (having strong galactic concentration and small unsystematic motions), and among stars which have entered our system from the outside by invariable stars of "earlier" spectral type and invariable M-type stars (having no galactic concentration). Among the variable N-type stars of the former class, the long-drawn-out character of the light curves suggests the dying out of variability and development into invariable N-type stars.

Novæ.—A photograph, without comment, of the spectrum of Nova Aquilæ, 1925, is given by P. W. Merrill in *P.A.S.P.*, **38**, 387.

Nova Pictoris (1925) has received a great deal of attention during the year. C. D. Perrine (*P.A.S.P.*, **38**, 28) points out that the nova not only has an unusually high galactic latitude (24 deg.) but is situated on a line extending from the great shoulder of the Milky Way in Puppis to the two Magellanic Clouds. This fact raises the question whether the Clouds may be an extension of the Milky Way, forming the outer end of a spiral arm containing dark matter.

Visual and photometric observations are recorded by B. H. Dawson in *Astron. Journ.*, No. 859, and J. S. Paraskévopoulos (*Harv. Bull.*, 831) gives the following values for the visual magnitude and colour index of the nova at various dates:—

1925.	Visual Magnitude.	Colour Index.
Sept. 7	3.50	-0.30
15	3.75	-0.45
Oct. 21	4.20	-1.20
Dec. 2	4.30	-0.90
4	4.30	-0.90

It may be recalled that Nova Pictoris was discovered on 1925 May 25 and reached maximum brightness on June 9. P. Davidovich (*Harv. Circ.*, 295) takes advantage of the slow rise to maximum by making determinations of the absolute magnitude of the nova by the spectroscopic method. The validity of this method when applied to novæ is questionable, but is supported by the similarity between the spectrum before maximum and the spectra of certain high luminosity stars of ordinary type. The procedure adopted was to compare the intensity ratios of eleven pairs of lines in the spectrum with the corresponding ratios for ι_1 Scorpii, so that the accuracy of the results depends on that of the adopted absolute magnitude of ι_1 Scorpii. It was found that the differences between the spectra of Nova Pictoris two weeks before maximum light and the day before maximum (the corresponding absolute magnitudes were -3.5 and -5 respectively) were comparable with those between a dwarf and a giant star of the same spectral class (F5). This leads to the conclusion that the rise of light of the nova was produced, not by an increase of temperature but rather by a decrease of density, which amounts to an expansion of the nova towards maximum light. There appears to be evidence of a decrease of temperature during the process, and assuming, as a first approximation, a temperature close to that of the Sun, the radius of the nova at maximum is found to be about ninety times the solar radius.

A curious fact connected with observations of the brightness of the star before maximum suggests the possibility that Nova Pictoris may be a link between novæ and irregular variables. The star is reported in *Harv. Bull.*, 823, as having been of the 3rd mag. on 1925 April 13 (about six weeks before discovery). H. S. Jones, however (*Observatory*, 49, 21), reports that W. Reid observed nothing to attract attention in the region a few days before discovery, and suggests that the star had decreased in brightness between April 13 and May 25. Further evidence of the above-mentioned transition character of the nova is advanced by C. D. Perrine (*P.A.S.P.*, 38, 28) on the ground of spectroscopic observations. In agreement with several other observers, he finds that the spectral development of the star, though in the normal direction for novæ, is exceptionally slow (*cf.* the slow rise to maximum after discovery), and thinks that the star might possibly mark a stage of stellar activity, not far removed from the α Cygni and P Cygni conditions, between those of novæ and ordinary stars.

In apparent contradiction to this, however, he suggests in a later paper (*P.A.S.P.*, 38, 116) that Nova Pictoris forms the missing link between novæ and η Carinæ. This conclusion is based on a practically perfect agreement between the spectra of Nova Pictoris (photographed in 1925 December) and η Carinæ (photographed in 1919). Several investigators remark on this resemblance, *e.g.* W. H. Wright (*P.A.S.P.*, 38, 232) and H. S. Jones (*Observatory*, 49, 157), the former of whom, in a study of the spectrum changes up to May, finds evidence of a nebular envelope to the star. His paper is accompanied by some beautiful illustrations of the successive spectra. P. Davidovich, however (*Harv. Bull.*, 837), while acknowledging that the spectra of

Nova Pictoris and η Carinae are somewhat similar, points out that there are conspicuous differences which cannot yet be definitely accounted for. He tentatively suggests that they might be due to a difference of density between the two stars. The same writer reports on the progress of the spectrum between 1925 December and 1926 June in *Harv. Bull.*, 839, and in No. 835 he gives tracings, with comments, of the intensity distribution in the spectrum, obtained by means of the Moll microphotometer. The method should prove useful in elucidating the structure of the broad bands which characterise the spectra of novæ.

The most detailed account of the spectrum changes of Nova Pictoris up to March 13 is given by J. Lunt (*M.N.*, **86**, 498; a preliminary account appears in *Observatory*, **49**, 57). The general conclusion is drawn that the phenomena of novæ are due to the swelling up and bursting of a star owing to some release of atomic energy and atomic or even molecular rearrangement. A somewhat similar, but more detailed, opinion is expressed by W. H. Pickering (*P.A.S.P.*, **38**, 208), who believes that novæ arise from the collision of stars with bodies of planetary size, the collision serving to liberate energy supplied by atomic decomposition within the stars.

E. A. Milne (*M.N.*, **86**, 459) indicates a possible cause of the Doppler displacements in the spectra of novæ. He points out that if an atom in a stellar atmosphere, normally in equilibrium under radiation-pressure and gravitation, acquires in some way an outward velocity, the radiation it will then absorb, owing to the Doppler effect, will be the intenser radiation on the violet side of the centre of its normal absorption line, and the atom will therefore be accelerated outwards. This exposes it to still more intense radiation, so that the velocity continues to increase up to a maximum prescribed by the weakening of the radiation either under the inverse square law or through the presence of a neighbouring absorption line. This maximum velocity is calculated and found to be of the order of the velocities indicated by the novæ line displacements, which are held to be probably due to the ejection and subsequent acceleration of showers of atoms by the increased radiation-pressure when the star brightens.

β Lyræ Type and Eclipsing Variables.—A new method of measuring colour changes of stars, and hence their temperatures, with particular reference to its application to β Lyræ, is described by L. Terkán in *A.N.*, 5422. The field of the telescope is provided successively with illumination of two constant but different intensities, and the reading of an arbitrary scale attached to the eyepiece is taken when the image of the star just disappears on moving the eyepiece inside or outside the focus. By choosing two stars of known magnitude the scale can be calibrated, and the magnitude of any other star is shown to be a linear function of the logarithm of the scale reading. Separate equations are given for extra- and intra-focal disappearances. By using colour filters, the magnitudes corresponding to red, green, and blue light are similarly determined, and equations are given expressing the differences, $m_r - m_b$ and $m_g - m_b$, in terms of the temperature and magnitude in ordinary light of the star. The varying absorption of the Earth's

atmosphere for different colours is investigated and allowed for. The results obtained are in good agreement with those of Wilsing. Details are given of the measurements for β Lyrae, extending from 1913 September to December, and a temperature curve is drawn with a comparison light curve. Attention is directed to three important conclusions: (1) Both components have high temperatures (the range from minimum to maximum is about 8000 to 12,000 deg.), the temperature of the companion being somewhat higher than that of the principal star. (2) During the chief minimum the companion is eclipsed by the principal star. (3) The smaller changes in brightness are associated with the larger changes in temperature (or, more strictly, in colour); *i.e.* the amplitude of the temperature curve is greater when that of the light curve is smaller.

In *P.A.S.P.*, **38**, 264, J. A. Pearce reports an investigation of the O-type eclipsing variable H.D. 1337, which is "the most massive ($70 \odot$) and the earliest (type O8.5) of the few eclipsing binaries thus far determined."

B.A.N., No. 95, contains a note by E. Hertzsprung, reporting observations of a star (H.D. 96214) which appears to be an eclipsing binary, although it has been found faint on only one night out of 147. Miss A. J. Cannon and Miss Woods (*Harv. Bull.*, 837) confirm the variability, and Miss Cannon gives a period of 176.06 days—an extremely large value for an eclipsing binary. The eclipse must last at least forty-eight hours.

The distant companion C of Castor, found by Adams and Joy in 1920 to be a spectroscopic binary, is now found independently by H. van Gent (*B.A.N.*, No. 97) and A. H. Joy and R. F. Sanford (*Ap. J.*, **64**, 250) to be an eclipsing variable. Dimensions determined from the combined photometric and spectrographic elements are given by the latter observers.

A consideration by J. Schilt (*P.A.S.P.*, **38**, 129) of the magnitude ranges of ten eclipsing variables with periods less than half a day (W Ursæ Maj. type) in relation to those to be expected on the assumption of given orientations of the orbital planes to the line of sight (the ellipsoidal shapes of the stars being taken into account) reveals an apparent deficiency of stars whose orbital planes pass near the Sun. Such stars would show the greatest light ranges, and could not have been overlooked. A defect in the ellipsoidal theory for this type of variable stars is suggested. G. Shajn, however (*M.N.*, **86**, 543), states that there is some evidence that the orbit planes of spectroscopic binaries tend to be parallel to the galaxy.

On the theoretical side, a paper by A. S. Eddington (*M.N.*, **86**, 320), calls for attention. Eddington investigates the reflection (more strictly, absorption and re-emission) of radiation falling on the faint member from the bright member of an eclipsing variable. He finds the heat albedo to be unity. The heat reflection coefficient was expected to be less than the light reflection coefficient, but was found to be so only in one star out of twelve examined. It is concluded from this that the "reflected" light is not amalgamated with the natural emission into black-body radiation, but is re-emitted by some mechanism which

preserves its original quality. The effect on the light of the system of the ellipticity of the stars is partially masked by the reflection effect; if the ordinarily observed ellipticity coefficient is c , and the reflection coefficient, b , the true ellipticity coefficient is $c + 0.36b$. It is pointed out that, owing to the unequal luminosity of the two hemispheres of the secondary respectively facing and shielded from the primary, radial velocity measurements will not refer to the centre of the disc. This affects the determination of orbits and masses and, when taken into account, brings TV Cass. much more into accord with the mass-luminosity curve. Incidentally, a reference is made to a determination by D. B. M'Laughlin of the dimensions of Algol, which agrees precisely with a calculation made from the mass-luminosity curve.

E. A. Milne (*M.N.*, **87**, 43), as a corollary to the foregoing paper, discusses the law of darkening of a disc on which radiation is incident from the outside, as in the case of a close eclipsing variable. He gives formulæ from which the reflected light and its distribution at various phases may be calculated.

In connection with these two papers, reference might be made to a paper by D. B. M'Laughlin (*Astron. Journ.*, No. 855), in which the elements of the orbit of the eclipsing binary, W Ursæ Min., are given. Here the stars are very large compared with their distance apart, and the reflection effect is therefore large. A surprising result of the investigation is that, although the stars are very close together, there is no indication of ellipticity according to the ordinary theory.

Cepheids.—An extensive discussion, including a catalogue and bibliography, of Cepheid variables is contained in the *Lyons Obs. Bull.*, **8**, 135, for a summary of which the reader is referred to *Observatory*, **49**, 378.

The progress made in the international scheme for co-operation in the observation of Cepheids is referred to in an article by F. C. Henroteau (*Pop. Ast.*, **34**, 493; see also *Lyons Obs. Bull.*, **8**, 1, 261).

Two valuable studies of ζ Geminorum have been published during the year. In a dissertation presented to the University of Münster, F. Becker discusses about 8000 observations of this star, extending from 1843 to 1922. He concludes that the visual magnitudes at maximum and minimum are respectively 3.88 and 4.32. There is no evidence of a change of amplitude, but secondary variations are probable, the time the star is below mean magnitude being less than the time above in the ratio 1:1.14. Elements of the variation are given. The photographic amplitude is 2.3 times the visual amplitude, and the calculated mean radius of the star is 18.6 times that of the Sun.

The other investigation, by Ch'ing-Sung Yü (*P.A.S.P.*, **38**, 357), deals with the spectrum changes of ζ Geminorum from maximum to minimum. The cyanogen bands (especially the one at λ 3883), which are quite absent at maximum light, are very pronounced at minimum. The [G] group also is strengthened on passing from maximum to minimum. [H] and [K] show puzzling periodic changes in intensity, but the most interesting change is shown by H_γ , which attains maximum intensity at $\frac{1}{4}$ -period after maximum light, and minimum intensity at the same interval after minimum light; i.e. the intensity curve of H_γ

shows a phase difference of 90 deg. compared with the light-curve and the band intensity curves. According to the pulsation theory, maximum volume also occurs 90 deg. after maximum light, and it is suggested that the variations of H_γ are due to pressure, and not temperature, changes. The spectral type of the star (estimated from the ultra-violet region) changes from F8 at maximum light to G5 at minimum, as compared with a change from F9 to G0 found by Adams and Joy from the less refrangible region. Reasons are given for preferring the range now determined, which corresponds, according to microphotometer measurements of the continuous background as well as to spectral types, to an effective temperature variation from 7200 to 5000 deg. This temperature change is held to account for the variation of intensity of the spectrum bands.

Observations of RR Lyræ which are recorded by J. Hellerich (*A.N.*, 5433) show an irregularity at "epoch 29." It is suggested that either a sudden change of period has taken place or that there is a sine-form inequality which reached its maximum phase at that epoch. The existence of a secular change of period is regarded as improbable.

Elements and light-curve of AA Aquilæ—one of the small group of Cepheids for which a change in the form of the light-curve has been established—are given by N. Ivanov in *A.N.*, 5457.

The study of the differential motions in the atmospheres of Cepheids shown by various spectrum lines, which was begun a year or two ago at the Observatory of the University of Michigan (see *M.N.*, **86**, 254), is carried a stage further by R. H. Curtiss, who gives a detailed discussion of the effect as observed in W Sagittarii (*P.A.S.P.*, **38**, 148). A consideration of the possible influence of the "blend" character of the lines shows that the observations cannot wholly be accounted for in this way. Assuming, therefore, the deduced differences in velocity of atoms at different chromospheric heights to be real, the question of interpretation is considered at some length. Support is given to the hypothesis that the effect arises from sub-atmospheric pulsations, communicated first to the lowest levels and successively to higher ones, the effective absorbing level for any line being assumed to rise with the chromospheric height of the line in the Sun. The resulting atmospheric movements would be complex, and other physical conditions also might contribute to the observed differential movements, *e.g.* convection and radiation-pressure. Atmospheric pulsations might be responsible for an important share of the light variation of Cepheids, and might help to explain the marked delay of light maximum in relation to the instant of greatest compression according to the pulsation theory as discussed by Eddington. The same phenomenon might also explain the irregularity following maximum light in W Sagittarii. The observations suggest that the atmosphere of this star is very extensive, but owing to the unknown influence of convection effects, this cannot be established.

Some doubt is thrown on the reliability of this method of investigation, however, by an attempt on the part of T. S. Jacobsen (*L.O.B.*, No. 379; a summary of the paper is given in *P.A.S.P.*, **38**, 249) to repeat the observations. Jacobsen, using data of the highest possible

degree of precision obtained by means of a three-prism spectrograph, finds no differential motions for δ Cephei and only slight ones for η Aquilæ. These results, however, are said to be only preliminary. In addition, radial velocity curves are given for δ Cephei, η Aquilæ, ζ Geminorum, and W Sagittarii. The observational points lie very close to the mean curves, so that the variations of radial velocity are quite smooth. A shortening of period of δ Cephei and a lengthening of period of η Aquilæ are indicated by comparison with earlier observations, and the numerical values agree well with those determined from photometric data. A shortening of period is found for ζ Geminorum, which is confirmed by other spectroscopic, but not by photometric, observations.

Two important statistical studies of Cepheid variation have been made. In *B.A.N.*, No. 96, E. Hertzsprung discusses the light curves of 37 Cepheids distributed over almost the whole range of period known for these stars. Cluster variables with periods of about half a day are not considered. There is no very marked relation between period and range of variation, although the greater ranges are found among the longer periods. The relation between form of light curve and period is more definite. Its chief characteristic is the position of the secondary wave with regard to the main one. For periods shorter than 6 days there is no secondary wave. Above 6 days the secondary wave appears on the descending branch of the light curve, and moves towards the left with increasing period, passing symmetrically through the maximum for periods between 10 and 13 days and thereafter appearing on the ascending branch. For periods longer than 16 days the secondary wave seems to have died out, but there still appear to be characteristic changes depending on the periods. More data are required for these stars.

The other paper is by J. Schilt (*Ap. J.*, **64**, 149), who deals with statistical properties of galactic Cepheids having periods longer than one day. The stars considered are the 163 variable stars listed in the *Katalog und Ephemeriden veränderlicher Sterne für 1926*, having periods between 1 and 80 days, which are not known to be eclipsing binaries. In the Sagittarius-Aquila region the frequency curve shows a maximum for $\log P = 0.84$. In other regions of the galaxy the period for maximum is decidedly shorter. In the smaller Magellanic Cloud, the period of maximum frequency is approximately equal to that for the galactic Cepheids in the hemisphere opposite the Sagittarius-Aquila region. For stars with $\log P$ between 0.8 and 1.0, the median apparent magnitude, proper motion, and absolute magnitude are systematically small. There is no decrease of apparent magnitude and proper motion for periods longer than 10 days, as would be expected from a uniform distribution in density and velocity. The data appear to indicate a discontinuity or irregularity in the various characteristics, corresponding to a period of about ten days, suggesting that the galactic Cepheids are composed of two classes, but the data are not above suspicion, and, further, it is regarded as probable that the usual spectral criteria for luminosity do not apply to Cepheids unless differences in spectral type are taken into consideration.

The problem of the origin and nature of Cepheid variation has continued to attract a great deal of attention, which has gathered round

the pulsation theory of Shapley and Eddington and the rotational fission theory of Jeans. E. Persico (*M.N.*, **86**, 98) finds that the rate of decay, through viscosity, of the pulsations of a star, according to the former theory, would be small enough to escape observation, but J. H. Jeans (*M.N.*, **86**, 328, 444) shows that there is a radiative viscosity which, in stars of large mass, quite outweighs the ordinary viscosity considered by Persico. W. Baade (*A.N.*, 5468) describes a method by which the pulsation theory might be tested. He first of all reinterprets the orbital elements of δ Cephei, deduced on the binary star assumption, in terms of the pulsation theory, the elements then being parameters by means of which the oscillation of the stellar surface can be analytically represented. He obtains in this way a pulsation curve, which is compared with the light and radial velocity curves. The pulsation curve has its minimum at about the middle of the rising branch of the light-curve, and its maximum at about the middle of the falling branch. The pulsation curve is symmetrical on either side of maximum or minimum, but the minimum points are much sharper than the maximum. The marked asymmetry of the light-curve is ascribed to the fact that the light variation has a dual cause, viz. the pulsation variation proper, and the surface temperature variation. On the assumption that the star radiates as a black body, it is possible to separate the two factors and so provide a test of the pulsation hypothesis. Thus, the Stefan-Boltzmann law enables the ratio of the radii at maximum and minimum to be determined in terms of the corresponding bolometric magnitudes and surface temperatures, while the observed changes of radial velocity provide a value for the difference of these radii. Hence, if we know the bolometric light variation of the star and also its variation of surface temperature, we can calculate the radius (and therefore, from the surface temperature, the absolute brightness) at each phase of the pulsation. A comparison between the absolute brightness thus derived and the otherwise known absolute magnitude of the star would serve as a test of the pulsation hypothesis. Existing data are insufficient to enable the test to be applied (the pulsation variation is estimated to be at most 0.20 mag.), but it is suggested that by means of simultaneous photovisual and photographic observations, photovisual light-curves and colour-index curves might be drawn from which temperatures might be deduced.

A. S. Eddington (*Observatory*, **49**, 88) calls attention to an argument against all theories of Cepheid variation which identify the period of light change with the period of rotation of the star (*e.g.* Jeans's theory). The calculated equatorial velocity would require very broad spectrum lines, owing to the Doppler effect varying continuously from one limb to the other. In the case of δ Cephei the breadth of the lines would be greater than 3 Å, which is contrary to observation. Jeans replies in *Observatory*, **49**, 125, that, according to his theory, the rotation period which is to be identified with the light period is that of the inner core, which he shows to be much less than that of the outer layers, so that no broadening of the spectrum lines of the magnitude which Eddington suggests is to be expected.

On the other hand, evidence in favour of the rotational fission

theory as contrasted with the pulsation theory is adduced by Jeans (*M.N.*, **86**, 86) in a discussion of the ability of the respective theories to explain the following two facts of observation: (1) the intensity of radiation is in phase with the maximum velocity of approach, and not with the length of the radius; (2) the light curves are unsymmetrical, as though the motion were not reversible in time. Jeans shows that the fission theory satisfactorily explains the first fact, but only partially accounts for the second, whereas the pulsation theory is unable to explain either. (See, however, the paper of Baade referred to above.) A further advantage of the fission over the pulsation theory is that it, alone of the two, provides sufficient duration of the Cepheid state to allow for the number of Cepheids found in the sky. The analysis, however, is held to constitute, at best, a rough preliminary survey. In *M.N.*, **86**, 379, J. J. M. Reesinck questions the rigidity of Jeans's demonstration that the pulsation theory is inconsistent with fact (1), but Jeans upholds the validity of his argument in *M.N.*, **86**, 575.

An extensive study of the Cepheid problem, and of δ Cephei in particular, is contained in a pamphlet by Reesinck entitled, "Onderzoekingen over Delta Cephei en over het Cepheidenprobleem" (H. J. Paris, Amsterdam). Following an introduction in which the properties and leading theories of Cepheid variables are summarised, the substance of the pamphlet is divided into three sections. In the first, colour measurements of δ Cephei at various phases are dealt with, and a method of investigation used by the author is described. In this method a wedge photometer is attached to an equatorial, and red and blue colour filters are placed alternately in front of the eyepiece. Details are given of the method of calibration of the scale and deduction of magnitudes in the two regions of the spectrum. The following three conclusions are drawn: (1) The amplitudes of δ Cephei for light of effective wave-lengths 6200, 4600Å, are respectively $0^m.68 \pm 0.07$ and $1^m.03 \pm 0.07$. (2) There are strong indications that the effective temperature at a point on the ascending branch of the light curve of δ Cephei is higher than that at the corresponding point of the descending branch; further investigation is very desirable. (3) The values of $\frac{C^2}{T}$ for δ Cephei at maximum and minimum are respectively 2.69 and 3.39, and the bolometric amplitude is $+ 0^m.42$. These values, however, are very uncertain. The second section is concerned with the relative intensities of the spectrum lines at different phases. The results of different observers agree that, on passing from minimum to maximum, the high temperature lines are strengthened with respect to the low temperature lines, but different interpretations of this fact are possible. Ten spectrograms of δ Cephei, from the Lick and Victoria observatories, are analysed by the method described in *B.A.N.*, Nos. 79 and 87 (see *M.N.*, **86**, 255), and values of the temperature and gravity parameters, p and q , are derived and discussed. It is concluded that in the region of the spectrum examined (1) the temperature is higher during increasing brightness than during decreasing brightness; and (2) during increasing temperature the ionisation is probably less than during decreasing temperature. In the last section of the paper, the theory of the atmo-

sphere of a pulsating star is considered mathematically. It is shown that Eddington's assumption that, in the outer layers, "the temperature oscillations are determined by the heat received and radiated, rather than by compression and rarefaction," is not justified, and that for pulsations of small amplitude, all aspects of the oscillation must be in phase with one another. Consequently, the pulsation theory, in the form given by Eddington, cannot account for the fact that the maximum radiation takes place at the time of greatest velocity of approach. It is concluded also that, at the surface of a pulsating star of the type considered by Eddington, deviations from adiabatic pulsation take place, which, however, do not involve any change of phase.

A generalisation of Jeans's theory is put forward by P. ten Bruggencate (*A.N.*, 5460; *M.N.*, 86, 335; *Naturwiss.*, 14 Jg., p. 905), who draws attention to certain phenomena shown by Cepheid variables which are not satisfactorily accounted for by either Eddington's pulsation theory or Jeans's fission theory in its present form. The chief difficulties are: (1) The fact that the normal secondary maximum does not appear in the light curves of shorter-period Cepheids, which often show, on the contrary, irregular oscillations in brightness associated with spectrum peculiarities; (2) the explanation of the period-spectrum relation, by which higher temperatures are associated with shorter periods. In connection with the last point it is stated that, in the Russell diagram, there is a sharp limit on the high temperature side to the occurrence of long-period Cepheids, while short-period Cepheids reach temperatures as high as any attained by normal stars. The scarcity of A-type giants with negative absolute magnitude makes it improbable that the long-period Cepheids develop into ordinary stars, and the idea that they might develop into short-period Cepheids is ruled out by the fact that in the globular clusters M₃ and M₁₃, the older (M₁₃) is richer in long-period and the younger in short-period Cepheids. It is concluded that at the end of the long-period Cepheid state a star makes a sudden jump on the Russell diagram.

In order to explain these phenomena Jeans's fundamental assumption is adopted, viz. that the Cepheid condition is an oscillation about an ordinarily stable, but secularly unstable, state of a star. Jeans's own theory provides for this, but is too restricted to account for the short-period Cepheids. Dynamical considerations, based in part on the work of Milne and von Zeipel, lead to the conclusion that a star which, without rotation, would obey Eddington's theory of normal stars, will, when in rotation, acquire a type of secular instability which is a function of its mass. If the mass is large, a pear-shaped figure is formed, leading ultimately to fission (T-type instability); if the mass is small, the star becomes lens-shaped, and equatorial matter is shed (A-type instability). In stars of intermediate mass, both types of instability occur together. By a generalisation of Jeans's theory it is then possible to remove the above-mentioned difficulties. It is assumed that the masses of Cepheids are such that both T- and A-type instability co-exist, and that the primary variation arises from the former. Longer-period Cepheids are then accounted for, as regards both present and future state, by Jeans's original theory. In Cepheids of shorter period (low luminosity,

small mass), however, the relatively large A-type instability gives the equilibrium figure a symmetrical surface, so that there is no light variation arising from a visible surface varying in area through rotation. The secondary maximum is therefore absent. Irregular secondary variations appear, however, through equatorial loss of matter. The period-spectrum relation is explained by the requirement pointed out by Jeans, that loss of matter moves the spectrum towards an earlier spectral type. Hence high temperature goes with small mass (low luminosity, short period). The abandoned matter can then be assumed to play the part of the satellite suggested by Henroteau (see *M.N.*, **86**, 256) to explain certain anomalies in the behaviour of short-period Cepheids. It is further suggested that short-period Cepheids develop into planetary nebulae through their equatorial loss of matter and continuously increasing effective temperatures. Evidence of this course of development is drawn from globular clusters, from the relation between spectral type and radial velocity, and from the space distribution of the stars.

H. Vogt, however (*A.N.*, 5480), criticises the work of Milne (*M.N.*, **83**, 118) on which ten Bruggencate's conclusions are partly based, on the ground that an erroneous interpretation is given to an equation occurring therein. He finds that the final equilibrium figure (whether pear-shaped or lens-shaped) assumed by a contracting rotating star depends only on the value of γ (or the polytropic index, n), being quite independent of the ratio of gas- to radiation-pressure (and therefore, presumably, independent of the mass of the star). By assuming, however, that the source of energy in the star is strongly concentrated towards the centre, he finds an explanation of the fact that stars—especially those of larger mass—divide by fission into double stars.

Von Zeipel's work, which also was referred to in ten Bruggencate's paper, is further adversely criticised by Jeans in *M.N.*, **86**, 578.

Long-Period Variables.—Vol. 79, Part 2, of the *Harvard Annals* has appeared during the year. It contains particulars of maxima and minima of 272 long-period variables, derived from visual observations made during the years 1900–1920, by L. Campbell. Revised elements of light variation are given for a large number of the stars. The contents of the publication are summarised in *Harv. Bull.*, No. 838.

In *A.N.*, 5433, A. V. Nielsen discusses the apparent secular change of period of R Hydræ, and concludes that it is in reality a long-period oscillation, similar to that found in the periods of many other Miratype variables, and that a maximum value of the period is to be expected.

The results of a colorimetric investigation of R Scuti (spectral type K-M) are considered by H. Vogt in *A.N.*, 5454. Data are obtained for the variations of visual and bolometric brightness, effective temperature, and angular diameter of the star throughout a complete period. The effective temperature curve closely follows the variations of visual brightness, and the common maxima and minima coincide respectively with the minima and maxima of the angular diameter curve. The bolometric magnitude, on the other hand, remains almost constant throughout (a similar phenomenon was reported by J. Hopmann, in *A.N.*, 5318, for Cepheid variables and χ Cygni), and is practically identical

with the value which the star should have according to Eddington's theory if it were in equilibrium. The slight changes in bolometric magnitude agree closely with those required by the theory on account of changes of effective temperature. It is deduced that the star, while undergoing large changes of volume, passes through a series of conditions with regard to pressure, density, and temperature distribution which are approximately those of equilibrium. Consequently, a star—especially a giant star of the later spectral classes—may experience large oscillations of volume and visual brightness through a small inner or outer disturbance.

In *A.N.*, 5469, H. Ludendorff, in continuing his investigations of Mira-type variable stars, points out some empirical relationships between length of period, spectral type, and form of light-curve. The light-curves are divided into three classes (each of which is further subdivided), viz.: (α) Ascending branch of curve decidedly steeper than descending branch; minimum, with a few isolated exceptions, always broader than maximum. (β) Ascending branch very little, or not at all, steeper than descending branch; light-curve essentially symmetrical. (γ) Light-curve with step, or hump, in ascending branch, or with double maximum. For Me stars—the only ones for which there are sufficient data to generalise—there is a relation between period and form of light-curve shown by the following distribution:—

Form of Light-Curve.

P (days).	α .	β $\alpha-\beta$	γ .	Peculiar.	Total.
91-109	1	31	5	3	40
210-250	17	20	1	2	40
251-279	19	18	2	1	40
279-318	29	10	1	0	40
318-342	21	17	0	2	40
344-396	26	6	7	1	40
>398	30	2	8	0	40
Totals	143	104	24	9	280

Thus, with increasing period, the prevailing form of light-curve changes from β to α . There is also a relation between spectral type and form of light-curve indicated by the following distribution:—

Spectral Type.	α .	β $\alpha-\beta$	γ .
Me	125	53	18
Se	5	9	2
Mc	2	7	3
N, R	1	20	1

The data for K, Ma, and Mb stars are scanty, but, so far as they go, indicate rather uncertainly a distribution similar to that of the Me

stars. The stars considered in each class were those with periods greater than 250 days. The conclusion is drawn that there is a systematic difference between Me and other Mira-type variables. The latter (especially classes N, R) tend to show a broader maximum relative to minimum than do the Me stars. A relation between spectral type and mean value of period is shown by the following figures :—

Spectral Type.	P_m (days).	No. of Stars.
Me	302	314
Se	361	18
K, Ma, Mb	207	24
Mc	305	15
N, R	404	24

Data are also given showing relations, within class Me, between spectral type (classified as Mae, Mbe, Mce from the character of the continuous spectrum) and period. Finally, a relation between h (the ratio of brightness, $H_\delta : H_\gamma$, of the hydrogen emission lines), mean period (in days), and spectral type is revealed by data in the new Draper catalogue, viz. :—

h .	Mac.		Mbe.		Mce.	
	P_m .	n .	P_m .	n .	P_m .	n .
< 1	235	22	203	9	} 272	5
1	229	27	275	37		
1.1-2.9	344	10	278	23	386	6
3.0-5.0	329	9	319	31	336	16
> 5	341	3	357	9	396	14

Here n denotes the number of stars considered. It thus appears (taking the uncertainty of the observations into account) that for each spectral class the length of period increases with increasing h . (In the paper a reference is made to a dissertation by H. Thomas (Berlin) entitled, "Eine Kritische Darstellung unseres gesamten Wissens und unserer theoretischen Vorstellungen von den Veränderlichen vom Mira-Typus." This has not been accessible to the writer of this note.)

In relation to these generalisations, a paper by L. Campbell in *Harv. Bull.*, 836, is of some interest. Campbell gives light-curves of R Centauri and R Normæ, which closely resemble one another and are similar in form (though, of course, widely different in scale) to that of β Lyræ. These stars show secondary maxima and minima more strikingly than any others of the long-period class. The periods are respectively 564.3 and 487.5 days.

A valuable and extensive spectrographic study of Mira is described by A. H. Joy in *Ap. J.*, **63**, 281, and more briefly in *P.A.S.P.*, **38**, 260. Even a summary of the results would be too long for inclusion here, and the following remarks refer only to that part of the investigation which is regarded as having a special bearing on the problem of the

origin of long-period variation. If the velocity curve shown by the absorption lines be interpreted as a spherical pulsation, the relative amplitude becomes of the same order as that of Cepheids. Alternative explanations are non-spherical pulsations and atmospheric currents. Considerations of orbital dimensions prohibit the assumption of an explanation in terms of a companion. The emission lines play little or no part in the light variation. Those of hydrogen and the low temperature lines of iron and magnesium give the same velocities, irrespective of the times of their first appearances. Even the emission lines of silicon and ionised iron, which are produced under conditions of greater excitation, share the same velocity changes in a less degree. These facts suggest that the emission lines arise in a moving stratum or shell rather than in isolated prominences. Except at minimum light, when the bright lines disappear, the velocity of this shell is always outwards with respect to the reversing layer. The location of the emitting layer relative to the absorbing layer cannot be determined conclusively. The observed temperatures at maximum and minimum (2300 and 1800 deg. respectively) connect the problem of the variation more closely with that of other types of physical variation. Partly owing to the absorption produced by the titanium oxide bands at minimum, the range of bolometric magnitude is much smaller than the visual range, and it is suggested that the whole group of physical variables may be found to form a sequence from the shortest to the longest periods. The companion of Mira is a most unusual star.

Concerning the theory of long-period variation, two other papers should be mentioned. The first, by W. E. Bernheimer (*Zeits. f. Phys.*, 36, 4, 302) maintains that the fundamental principle of la Rosa's ballistic theory of variable stars is inconsistent with solar observations.

The second, by J. Hopmann (*A.N.*, 5455) contains an account of a new theory suggested by recent observations. Among those observations is to be specially noted the fact that while the effective temperature oscillates with the visual brightness of the star, the bolometric magnitude undergoes only very small variations. After showing the inadmissibility of certain hypotheses formerly advanced, Hopmann calls particular attention to the suggestions of Campbell and Merrill which, though untenable in their original form, can be combined into a hypothesis capable of explaining all known facts. At the time of visual minimum the star is assumed to be covered by a thick uniform cloudy veil emitting heat radiation (temperature about 1500 deg.). This veil absorbs the radiation of the underlying photosphere, and soon hot gases break through in many relatively small places more or less uniformly distributed over the surface. These hot gases give rise to the emission lines with their violet displacements. In middle phase the temperature of nine-tenths of the veil has sunk to 1400 deg. or less, and the remaining one-tenth is at about 2500 deg. Only the latter contributes to the visual and photographic brightness. At visual maximum the hot places occupy only one-thirtieth of the surface, but they are much hotter than before, the remaining colder parts of the veil having sunk to about 1000 deg. Approximately at this time the energy current from the (to us inaccessible) photosphere of the star

ceases, the small hot masses of the veil impart their heat to the surrounding cooler portions, the radiating surface grows rapidly larger and the temperature of the hot masses smaller, until finally the original state of a uniform veil is recovered, and the process begins again. Various features of the hypothesis are compared with observation.

Irregular Variables.—Observations of the peculiar variable, X Persei, are given by A. N. Brown in *M.N.*, **86**, 101.

In *A.N.*, 5458, B. Okouneff discusses observations of R Lyræ (an irregular Mb-type variable) made since its variability was discovered by Baxandell in 1856, with special reference to the observations of the years 1908–24. He finds that the period varies from 40 to 60 days, with an average of 50 days. The variation of period follows a sine curve with a period of 3000 days, but there is no evident regularity in the variation of amplitude and mean brightness.

The observations of the peculiar variable XX Ophiuchi (H.D. 161114) over a period of thirty-six years are discussed by H. Shapley and I. E. Woods in *Harv. Circ.*, 292. This star has a normal magnitude 9.75, which is interrupted at irregular intervals by sudden diminutions of brightness, the minima being of various forms and durations. Six such interruptions of brightness have occurred since 1890. The spectrum in 1921–23 showed emission lines of ionised iron, but in 1925 the most prominent feature was found by P. W. Merrill (*P.A.S.P.*, **38**, 45) to be wide absorption lines of ionised titanium.

In *A.N.*, 5446, A. A. Nijland records and discusses extensive observations of SS Aurigæ, in conjunction with the records of other observers. He finds that, as well as the “long” and “short” rises to maximum, there are also abnormal, more symmetrical rises, as with SS Cygni and RU Pegasi. The interval between successive maxima of any kind is never less than 21–23 days, and when the minimum interval occurs, it is always preceded or succeeded by another exceptionally short interval, the two intervals together amounting to about 70 days in all observed cases. He assumes that for 20 days before and after any maximum, the star is always faint, and that if the interval between two maxima is less than 68 days, an intervening maximum cannot occur. Although no clear law in the succession of maxima can be established, there are suggestions of an underlying regularity. Thus, in the series of observations considered, two “short” maxima occur in succession thirteen times, while two “long” maxima succeed one another only three times. The periods obey no known law, but when treated statistically are distributed symmetrically round a value of 56 days. There is a correlation between short and long periods on one hand, and short and long maxima on the other, such that short periods (less than 40 days) never occur between two long maxima, and long periods (greater than 90 days) never occur between two short maxima. The mean light-curves for the long and short maxima are discussed. Since the duration of the maximum is not always the same, the individual curves deviate from the mean more than is the case with regular variables.

A list of variables of R Corona Borealis type is given and discussed by F. de Roy in *Lyons Obs. Bull.*, **8**, 121.

H. D.

Note on the Planet Jupiter.

The aspect of Jupiter in 1926 was very unusual. As in 1919, certain well-known features were invisible, and it seems probable that they were obscured by overlying vapours. Thus the "hollow" in which the Red Spot normally lies, the South Tropical Disturbance which—save for its temporary obscuration in 1919–20—has been continuously visible since 1901, and the south component of the South Equatorial belt were all lost to view. Moreover, the region usually occupied by these features became the whitest part of the disc, while belts still further south were later involved in the obscuration, and faded to such an extent as to be almost invisible except in certain longitudes. The Red Spot itself, however, remained unaffected and, as in 1919, actually became more conspicuous than it had been for some few years. Observers generally have not yet reduced and published their observations, but in view of the probable recovery of the features above mentioned, and the fact that in 1920 the process was marked by phenomena of an abnormal character, it seems desirable to draw the attention of planetary observers to the importance of early observations when Jupiter reappears in the morning sky.

Among the notes on Jupiter published during 1926 are the following:—

In *L'Astronomie* for August, F. Quenisset gives an account of observations made at the Juvisy Observatory which illustrate the unusual aspect of the planet above mentioned. In the September and December numbers of the same publication will be found drawings by E. M. Antoniadi which show the resolving power of the great Meudon refractor and its value in planetary researches. M. Antoniadi's contribution to the September number also contains some useful historical notes on the work of earlier observers of the planet, and presents in parallel columns the many points of similarity exhibited respectively by Jupiter and the sun. In connection with the frequently suggested analogy between these two bodies, it is interesting to recall Dr. Jeffreys' papers in *M.N.*, **83**, 350, and **84**, 534, in which he has presented the view—based on the density distribution of the major planets as deduced from their polar flattening, and seemingly supported by measurements of their radiation by Menzel and subsequently by Coblentz—that the temperature of these planets must be low. The account of a discussion of this theory at a meeting of the British Astronomical Association will be found in *B.A.A.J.*, **36**, 98 *et seq.* Letters on the same subject by Dr. Fountain and Dr. Jeffreys are published in *B.A.A.J.*, **36**, 121 and 153.

In the *Russian Astronomical Journal*, vol. i., Nos. 3–4, B. Fessenkoff has also discussed the constitution of Jupiter from a consideration of its figure. Finding the measured ellipticity much less than that of a homogeneous body rotating with the same angular velocity, he has concluded that the outer parts of the planet are "undoubtedly gaseous."

The general view of telescopic observers appears to be that the extensive and seemingly eruptive changes often noted in the Jovian

features indicate considerable stores of internal energy, whatever the temperature of the surface layers may be. But since on theoretical grounds it seems that Jupiter must long since have lost its "original heat," the question arises as to whether energy may not be generated by sub-atomic changes of some kind. If such a hypothesis should prove admissible, it might harmonise the divergent results of theory and observation, and restore to favour the hitherto generally accepted interpretation of the well-established observational similarity between Jovian phenomena and those of the sun.

An account of the changes in Jupiter's belts, illustrated by a drawing by L. J. Wilson, will be found in *Popular Astronomy*, **34**, 8, 241.

In *Observatory*, **628**, 280 (1926 September), T. E. R. Phillips calls attention to the recent developments and publishes a couple of drawings.

Publications and Memoirs—Three reports of systematic work on Jupiter appeared during 1926, and they all relate to the 1919-20 apparition. In view of the recent condition of the planet's surface, the publication of these reports at this time is opportune.

"La Surface de la Planète Jupiter, 1919-1924," by C. Luplau Janssen (*Publications de l'Observatoire "Urania," Copenhagen*, 2 série, No. 6) gives in considerable detail the observations made at the Urania Observatory during the years mentioned, but by far the greater part of them were secured during the 1919-20 apparition. They consist mainly of micrometric measures for longitude and latitude determinations, descriptive notes and drawings, and some general conclusions.

Observations des Surfaces Planétaires. Fascicule vii., 1919-20, includes the results of observations of Jupiter by M. G. Fournier at the Jarry Desloges Observatory at Setif. Unfortunately they only cover the short period of about two months, during which the planet was observed on 27 nights. The observations include a number of drawings, colour notes, determinations of position, and other data.

"The Twenty-Second Report of the Jupiter Section of the British Astronomical Association" (*Memoirs B.A.A.*, vol. xxvi., part iv.) deals exclusively with the 1919-20 apparition. In this report special attention is drawn to the very remarkable phenomena which marked the recovery of the features which had become invisible during the preceding year, and in particular to the abnormal drift in opposite directions of two pairs of spots which appeared in the South Tropical zone.

The interesting hypothesis that these two pairs of spots as observed were in reality a single pair carried along in a surface current of which the direction was reversed at the *p* end of the South Tropical disturbance is given in a paper by Mr. B. M. Peek in *B.A.A.J.*, **37**, 62.

Mutual Eclipses of the Satellites.—During 1926 the planes of the satellite orbits passed through the sun, and the computing section of the British Astronomical Association, under the direction of Major A. E. Levin, published tables of predicted times and other data for the resulting mutual eclipses. Such phenomena have scarcely ever been recorded previously. They have escaped notice because there is

usually no obvious sign of the approach of such an occurrence and they have consequently not been looked for. Fortunately the B.A.A. Tables enabled several observations to be made at the last apparition, and a discussion of them by Major Levin is given in *B.A.A.J.*, **37**, 136. Some discrepancies were found in the records—especially in the estimated decrease of light during eclipse—but practically new ground has been broken, and it seems that observations of such phenomena might provide data of value in any future discussion of the orbits of the satellites.

T. E. R. P.

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Erratum.

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London, Royal Society, *Philosophical Transactions*, 1665 1775,
vols. 1-65. Volumes 16, 17, 18, 19, 29, 30, 37 are wanting.

ADDRESS

Delivered by the President, Dr. J. H. Jeans, on presenting the Gold Medal of the Society to Professor Frank Schlesinger, for his work on Stellar Parallax and Astronomical Photography.

At the dawn of civilisation, when man awoke from his long intellectual slumber, nine muses were appointed to preside over his various activities. Only one muse was allotted to science, and that one was allotted to astronomy. Perhaps the high gods of Olympus who arrange these things had heard of no science beyond astronomy, or perhaps they thought it the only one worth encouragement; we do not know. But it is said that since then the claims of other sciences have been admitted, and a vast crowd of junior muses have been appointed to look after them. When they all meet in conclave, many of the latter report quite extraordinary rates of progress in their particular sciences, and it has sometimes been thought that astronomy, which started first in the race, has at times shown some tendency to lag behind.

To this Urania has always had a ready answer. She can point first to the immensity of her task; sciences such as geography, geodesy, and geology, whose field of action is limited to the surface of one tiny planet, can no doubt claim to be well on towards the completion of their tasks, but the exploration of an entire universe offers a task of a different order of magnitude. She can point also to the extraordinary difficulty of this task; after once the first obvious steps have been taken, the astronomer can get nothing of value except with instruments of almost incredible precision. Moreover, instead of being able to investigate phenomena when he pleases, he has to wait on Nature, and Nature moves very slowly in comparison with human life—the whole age of astronomy, as a science, bears the same relation to the ages of the stars that it studies, as does the last tick of the clock in the dying century to the century itself. Finally, she has often been heard to remark, with a mixture of pride and sorrow in her voice, that her science presents problems of such enthralling interest that only too few astronomers can be found to do their fair share of the fundamental work on which all progress must ultimately be based. We can rest assured that she is well satisfied when, as on the present occasion, our Society signals out for its highest honour one who has done not only a fair share, but a lion's share, of most valuable fundamental work.

To the ancients the intrinsic difficulties of astronomical science did not loom large. The age of the universe meant much the same thing to them as the age of the human race, and the size of the universe was believed to be of the same order of magnitude as the size of the earth. The moon, they agreed, was about the size of the Peloponnese: the sun, as anyone could see at an eclipse, was rather bigger. Aristarchus of Samos had, it is true, calculated that it must be eighteen or twenty times bigger, and had maintained that the fixed stars must be very

remote indeed. But he was far in advance of his time, even believing that the earth moved round the sun. The majority of the early astronomers held that the spheres of the moon, sun, planets, and fixed stars were all packed fairly closely together. For the most part they believed firmly in the principle they described as "the economy of nature," which prohibited the leaving of any unnecessary unoccupied space between the heavenly bodies—surely no scientific belief has ever been so utterly unwarranted by the facts! With this supposed principle firmly rooted in their minds, they naturally felt confident that it was a simple matter to determine the distances of the various heavenly spheres with fair accuracy. Later on, when the determination did not prove so easy as had been anticipated, it began to be felt that the impossibility of discovering any parallax motion whatever in the stars presented an objection of real force against the Copernican system of astronomy. It was on the absence of parallax motion that Ptolemy had based his argument that the earth was the unmoving centre of all the celestial spheres, and as century after century rolled by and no trace of parallax motion was forthcoming, it almost began to look as though Ptolemy had been right after all. Hooke, Römer, and Bradley, realising the fundamental importance of the question, attempted in turn to detect parallax displacements of the stars, and all their efforts ended in failure, although we must remember that Bradley's failure immediately resolved itself into a triumph—the discovery of aberration. This provided convincing evidence of the earth's orbital motion, but threw no light on the question of the distances of the stars.

Early in the seventeenth century Kepler had maintained that the stars were probably of the nature of suns, and that our sun was similar to the other stars. The observation that the brightest of the stars are, in modern terminology, some 25 magnitudes (10^{10} times) fainter than our sun, might well have suggested that the nearest of the stars must be some 100,000 times as distant as our sun, and so must have a parallax of the order of at most two seconds of arc. But, so far as I know, this type of argument hardly appeared until Newton advanced it in his *System of the World*. From the observed size of Saturn's disc he calculated that the sun must emit in all 2.1×10^9 times as much light as falls on Saturn. Although Saturn cannot re-emit all the light it receives, it appears rather brighter than a first magnitude star. Thus if the first magnitude stars are as luminous as the sun, they must be more than $\sqrt{(2.1 \times 10^9)}$ times as distant as Saturn. Newton conjectured their distance to be about 100,000 times that of Saturn, which corresponds to a parallax of $0''.21$.

Almost at the same time the converse of this argument began to appear. Although Bradley had not succeeded in obtaining a definite parallax for any star, he had proved in 1727 that that of γ Draconis could not exceed one second of arc. Assuming this result to be generally true for all stars, astronomers began to compute lower limits to the luminosities of the brighter stars and found that they were commensurate with that of the sun, as Kepler had maintained. In 1800

Herschel used this supposition to compute hypothetical parallaxes both for bright and for faint stars.

The year 1838 saw the whole situation suddenly transformed. For in that year Bessel, Struve, and Henderson independently found definite and distinctly different parallaxes for the three stars δ Cygni, α Lyrae, and α Centauri, and it first became possible to assert, on incontrovertible evidence, that the stars were not all at the same distance from the earth, and that the system of the stars formed a three-dimensional and not a two-dimensional structure. A workable method had been found for sounding the depths of space, and the universe lay open for exploration.

The general feeling of astronomers at the time is well shown in the address delivered by Sir John Herschel when, eighty-six years ago, he handed our Gold Medal to Bessel. He said: "I congratulate you and myself that we have lived to see the great and hitherto impassable barrier to our excursion into the sidereal universe, that barrier against which we have chafed so long and so vainly—*æstuantem angusto limite mundi*—almost simultaneously overleaped at three different points. It is the greatest and most glorious triumph which practical astronomy has ever witnessed. . . . Let us trust that, as the barrier has begun to yield, it will speedily be effectually prostrated."

The difficulties of the problem were so great as to put out of the question any such speedy prostration of the barrier as my predecessor of eighty-six years back appears to have hoped for. Although astronomical ability of the highest order was brought to bear, progress was slow. Peters did work of outstanding merit at Pulkowa, as did Gill also at a later date with the Cape heliometer. At Yale the heliometer was used also by Chase, Elkin, and Smith, while photographic methods were employed, although without much success, by Rutherford and Jacoby in America and by Pritchard at Oxford. In spite of the comparatively large number of workers, results appeared to be lamentably few. In 1901 Newcomb compiled a catalogue of stars of known parallaxes; their total number is only 72, of which 15 are designated as being "subject to more doubt than usual," while one is damned with four little dots which, we are told, means that it is "entirely unreliable." Even including the unreliable parallaxes, astronomy had been exploring the universe thrown open to it sixty-three years earlier at the rate of only about one star a year. The appearance of Newcomb's table, however, marked the darkest hour before the dawn. Three years previously, in 1898, a graduate student had presented to Columbia University a thesis for his doctor's degree with the title "The Præsepe Group: Measurement and Reduction of the Rutherford Photographs," by Frank Schlesinger. This contained very convincing evidence that a young astronomer had brought quite unusual skill, care, and ingenuity to the problem of the accurate measurement of stellar photographs. The use to which he contemplated turning these powers was indicated in a paper he read in the following year to the Third Conference of Astronomers and Astrophysicists—"Suggestions for the Determination of Stellar Parallax by means of Photography" (*Ap. J.*, 10, 242). In this paper he comments on "the neglect of the important subject of stellar parallax,"

estimating that "not more than 25 or 30 stars had known parallaxes which could be relied on to within $0''.05$." He sees very clearly that the task will be no easy one, and indeed that quite special precautions are necessary if results of a high order of accuracy are to be obtained from photography. The first difficulty he sees arises from the great difference in brightness between the near stars whose parallax is to be determined and the distant, and therefore faint, comparison stars against which, as a background, the motion is to be measured. If the faint stars are to appear at all on his plate, there is a danger that the image of the bright star will be too big to be bisected with accuracy. At first he tries desensitising that part of the plate on which the bright star is to appear, although he subsequently discards this plan for the better one of a rotating shutter with an adjustable cut sector. Always the object is to ensure that in the photograph the images of the parallax star and the comparison star shall be as similar in quality and intensity as it is possible to make them. He discusses two other points of importance, the need of guarding against distortion of the film after exposure, and the possible dangers of optical distortion resulting from peculiarities of the object-glass. That he was even then thinking of a fairly comprehensive programme is shown by the concluding words of his paper: "According to a conservative estimate, a single observer, working fifteen or eighteen hours per week at the telescope and employing the rest of his time in measuring and reducing, could give us in three or four years the parallaxes of 200 stars with an accuracy hitherto attained for only a score."

Five years later (*Ap. J.*, **20** (1904), 123) we obtain the first fruits of his ideas. In May 1903 he had moved from Ukiah to Yerkes, and the 40-inch Yerkes refractor was now at his disposal for the taking of plates. In his first paper from Yerkes he discusses further possible and important sources of error, describes efficient means of guarding against them, and gives a few parallaxes obtained with the 40-inch telescope. Although warning us that his results are only of a preliminary nature, we find that he had already attained to a very high level of accuracy. This paper contains the earliest published parallax of Krüger 60; the two determinations of greatest weight were $0''.265$ and $0''.278$ as against the present accepted value of $0''.257 \pm 0''.004$. He reached even higher accuracy with Struve 2398 (Pos. Med. 2164); his own measurements for this star gave a parallax of $0''.285$, while the best value at present available is $0''.287 \pm 0''.004$.

In March 1905 he was appointed Director of Allegheny Observatory, and circumstances compelled a slackening of his parallactic work; indeed, for the time he became a spectroscopist. But in 1910 and 1911 we find a series of seven papers in the *Astrophysical Journal* under the general title "Photographic Determinations of Stellar Parallaxes made with the Yerkes Refractor." They contain the results of work which had been done at Yerkes, but were not written up until some six years later, as leisure permitted, at Allegheny. In these papers, it is hardly too much to say, he examines practically all the reasonable sources of systematic error in photographic work, and when he cannot devise means for eliminating them altogether, he devotes much careful thought

to the end of reducing them to a minimum. He devotes endless care to the elimination of errors of the measuring machine, and arranges his methods so as to facilitate the mass-production of accurate parallaxes. The last of the seven papers contains a summary of the parallaxes of 32 stars.

The next group of parallaxes was determined with the Thaw photographic refractor at Allegheny, an instrument which required only about one-tenth of the time of exposure of the larger, but visual, refractor he had previously used at Yerkes. The results occupy two whole volumes, 4 and 5, of the *Allegheny Publications*. By this time others were, naturally enough, travelling the same road. In particular, Hinks and Russell had made a series of photographic parallax determinations at Cambridge which agreed with Schlesinger's work in showing the great superiority of the photographic method over all others. Schlesinger now succeeded in arranging a carefully planned scheme of co-operation between the seven observatories of Allegheny, Dearborn, Greenwich, McCormick, Mount Wilson, Sproul, and Yerkes. The results of this scheme of work up to the year 1924 are contained in his *General Catalogue of Parallaxes*. This contains the parallaxes of 1870 stars to a very high degree of accuracy. It is, I suppose, no exaggeration to describe it as one of the most useful and valuable publications the working astronomer has ever seen. A comparison of this catalogue of 1870 parallaxes with Newcomb's 1901 Catalogue of 72 parallaxes gives a vivid picture of the work done in twenty-three years; a large part of this was done by Schlesinger himself, a still larger part on his initiative, and all of it benefited by the use of the methods he had so skilfully devised. The gain in accuracy can be illustrated by comparing the first half-dozen parallaxes given by Newcomb with the parallaxes of the same stars taken from Schlesinger's Catalogue. The list stands as follows:—

	Newcomb (1901).	Schlesinger (1924).
β Cassiop.	0".15	0".071 $\pm$ 0".007
Groomb. 34	0".30	0".282 $\pm$ 0".006
ζ Tucani	0".06	0".146 $\pm$ 0".027
β Hydri	0".13	0".141 $\pm$ 0".007
α Cassiop.	0".04	0".016 $\pm$ 0".007
γ Cassiop.	0".20	0".182 $\pm$ 0".005

We notice that the average error in the Newcomb parallaxes for these six stars is about 0".040, while five out of six of the Schlesinger parallaxes have probable errors of 0".007 or less. The gain in accuracy is the greater part of a decimal place, while the Schlesinger Catalogue contains twenty-six times as many stars as the earlier list. Even this does not tell quite the whole story. For Newcomb discredits two of his best parallaxes (Groomb. 34 and α Cassiop.) with asterisks which he tells us indicates that they are "subject to more doubt than usual," while his two thoroughly erroneous parallaxes (β Cassiop. and ζ Tucani) have no such doubts cast on their trustworthiness. And the one parallax in his whole catalogue which Newcomb condemns as "entirely

unreliable" (50 Persei; $\varpi = 0''.04$) happens to agree exactly with Schlesinger's determination ($\varpi = 0''.046 \pm 0''.009$) to within the probable error of the latter! Schlesinger not only has given us reliable parallaxes, but has accompanied them, to use an absurd phrase, with reliable probable errors.

Having said this much as to our Medallist's record of work accomplished, I hope it will not appear ungracious to pause for a moment to contemplate the realms which remain to be conquered. The number of known stars within spheres of radii 2, 3, 4 parsecs, drawn round the sun as centre, is 3, 6, 18 respectively. In this count binary systems are treated as single stars, although Proxima Centauri is deemed to be distinct from α Centauri, and the sun is not counted since its presence is a pre-requisite to our making the calculation at all. Now if the stars in the neighbourhood of the sun were scattered at random, and were all known, the number of stars observed to lie in different spheres would be proportional to the cubes of their radii; if they were not all known there would, of course, be a falling off from this law for the spheres of greatest radii, since distant stars are more likely to remain unknown than near stars. In particular, if the 18 known stars were the total inside a sphere of 4 parsecs radius, the numbers to be expected inside the three spheres of radii 2, 3, and 4 parsecs would be 2.2, 7.6, and 18 respectively. These are near enough to the actual numbers of 3, 6, and 18 to justify the hope that the great majority of the stars within 4 parsecs are known. But 4 parsecs is the greatest distance for which such a hope can be entertained. With 18 stars lying within 4 parsecs of the sun, there ought to be a further 17 lying at distances between 4 and 5 parsecs; only 6 such stars are known: there ought to be 280 within 10 parsecs, whereas Schlesinger's catalogue only contains 86.

Thus even now our survey of the universe is tolerably complete only to a distance of about 4 parsecs; beyond this the number of known stars increases nothing like so rapidly as the cube of the distance. With present-day accuracy, trigonometrical parallaxes can be estimated to a probable error of, let us say, $0''.008$, so that the parallaxes of stars within 100 parsecs may be said to have a real physical significance. Of such stars there ought to be about 281,250, and at the present rate of progress the determination of their parallaxes would occupy astronomy for fully 1000 years to come.

Just now we compared astronomy's past 3000 years of existence to the last tick of the clock in a dying century; we may with equal justice compare the 3000 years next to come to the first tick in a new century—such is the proportion it bears to the total time our present stars may be expected to last. Looked at on this scale there may be thought to be plenty of time for a really exhaustive survey of the universe, and past progress may be accounted amazingly rapid. In one tick of the clock astronomy has come to birth, has developed the most difficult and accurate technique known to science, and has surveyed the universe, accurately and completely to 4 parsecs, and sketchily and imperfectly beyond. The next tick of the clock should see the accurate survey extended to well beyond 100 parsecs, and astronomy has a whole century of life before it. I fear there may be a fallacy

involved in the adoption of this point of view; it is that we do not know how long the human race will endure. At the very longest estimate, man has only existed for a hundred ticks of our clock, civilised man for only two or three, so that our race and civilisation would alike seem to be at the very beginning of their existence. And yet he would be a bold extrapolator who would assert with confidence that man is good for another three thousand million ticks on the ground that, if nothing unforeseen happens, the present stars will still be in existence at the end of that time. When we take a time-scale in terms of individual lives, we may still feel gratified at past progress, yet we cannot but feel awed by the magnitude of the task that remains.

While we all think of Schlesinger as primarily distinguished by his accurate parallax work—and Council so thought of him in selecting him as our Medallist for 1927—yet we also know that his interests and achievements extend into far wider fields. He has acquired amazing skill in all departments of astronomical photography, and is prepared to exercise this skill wherever it can, in his opinion, operate to the greatest advantage. As events have proved, he undoubtedly showed sound judgment in concentrating at the beginning of his career on parallactic measurements. Yet a paper in the *Astrophysical Journal* for 1899 shows that even in his early days at Ukiah his thoughts were turning in the direction of exact spectroscopic work. When he became director of Allegheny in 1905, he found himself in control of an observatory in which special arrangements had been made for carrying on the spectroscopic work which had been so brilliantly inaugurated by Keeler. For the time being he threw all his energy into this, and so it came about that the first three volumes of the new *Allegheny Publications* are almost entirely devoted to spectroscopic subjects, while parallaxes do not enter until volumes 4 and 5, both of which they monopolise.

Schlesinger's first work at Allegheny was to use the 30-inch Keeler Memorial Reflector to determine the orbit of Algol in conjunction with R. H. Curtiss. They designed a special spectrograph for use with the broad and rather hazy lines of early type spectra, and devised methods of solution such as were calculated to ensure the highest possible degree of accuracy. After this study of the orbit of Algol, Schlesinger led a general attack on the orbits of B-type binaries. The greater part of this and his other spectroscopic work was done in collaboration with his assistants, Curtiss (until 1907), Baker, Jordan, and Daniel, but the published papers show that Schlesinger himself did a large part of the actual work, as well as guiding the whole programme. He was the first to show what a high level of accuracy could be attained in the measurement of the somewhat unpromising and intractable spectra of B- and A-type stars. Among the systems he himself studied were δ Libræ, λ Tauri, u Herculis, and β Scorpii. He obtained results of great interest from each. In β Scorpii, in which the spectra of both components are visible, the H and K lines of calcium were found to appear as fine absorption lines which neither stood still nor moved with the main spectra of the two components, but showed a movement of the same period as the main system although with greatly reduced amplitude.

At Allegheny he re-observed photographically two zones of the *Astronomische Gesellschaft*, $+50^{\circ}$ to $+55^{\circ}$ and -2° to $+2^{\circ}$. Before he had finished measuring the plates he was appointed Director of Yale Observatory, so that the results appear in the *Yale Observatory Transactions*. In vol. 4 we find the positions and proper motions of 8359 stars in the zone $+50^{\circ}$ to $+55^{\circ}$, while vol. 5 contains 5833 stars in zone -2° to $+1^{\circ}$, and 1275 stars in zone $+1^{\circ}$ to $+2^{\circ}$. The short introduction to the former volume again gives evidence of the forethought and success with which he eliminates all possible errors. His mathematical judgment enables him to arrange his co-ordinates so that all errors are reduced to a minimum—in this case to second order terms only—while his mechanical ingenuity enables him to design mountings and measuring-engines which go far towards ensuring that there shall be hardly any errors to reduce. Other instances of his mechanical and optical ingenuity abound in all his work. Let me mention particularly his use of wide-angle double lenses for the determination of position, his adaptation of the Harvard plan of photographing “through the glass” to the determination of positions and proper motions, and his devising an entirely satisfactory rotating sector to cut down his star images to any required intensities.

He is at present engaged on plans for the conquest of the southern hemisphere, and has recently set up a Southern Yale Observatory at Johannesburg. The telescope was designed by himself and largely constructed in his own workshop at New Haven. At present it is intended primarily for parallax work, but I doubt if any of those who know his boundless energy believe that his southern programme will be limited to parallaxes for very long.

It is a matter of great regret to us all that illness has, at the last moment, prevented our Medallist being here to-day to receive his Medal in person. The formal presentation is accordingly deferred, but we hope he will come soon to carry it away, and with it, I am sure, will go your warmest congratulations on the vast amount of work of the highest order that he has already achieved, and your hopes that his output may be maintained at its present strength for many years to come.

Election of Officers and Council.

The following Fellows were elected as Officers and Council for the ensuing year :—

President.

Rev. T. E. R. PHILLIPS, M.A.

Vice-Presidents.

Sir FRANK DYSON, K.B.E., M.A., LL.D., F.R.S., Astronomer Royal.
A. S. EDDINGTON, Esq., M.A., M.Sc., LL.D., F.R.S., Plumian
Professor of Astronomy, Cambridge.

ALFRED FOWLER, Esq., F.R.S., Yarrow Research Professor of the
Royal Society, Imperial College of Science and Technology, South
Kensington.

Lieut.-Col. F. J. M. STRATTON, D.S.O., M.A.

Treasurer.

P. H. HEPBURN, Esq., LL.B.

Secretaries.

JOHN JACKSON, Esq., M.A., D.Sc.

H. KNOX-SHAW, Esq., M.A., D.Sc., Radcliffe Observer, Oxford.

Foreign Secretary.

H. H. TURNER, Esq., D.Sc., D.C.L., F.R.S., Savilian Professor of
Astronomy, Oxford.

Council.

A. C. D. CROMMELIN, Esq., B.A., D.Sc.

C. R. DAVIDSON, Esq.

HERBERT DINGLE, Esq., Assistant Professor of Astrophysics,
Imperial College of Science and Technology, South Kensington.

J. W. L. GLAISHER, Esq., Sc.D., F.R.S.

HAROLD JEFFREYS, Esq., M.A., D.Sc., F.R.S.

E. B. KNOBEL, Esq.

Major W. J. S. LOCKYER, M.A., Ph.D.

H. F. NEWALL, Esq., M.A., D.Sc., F.R.S., Professor of Astrophysics,
Cambridge.

JOHN H. REYNOLDS, Esq.

W. M. SMART, Esq., M.A., D.Sc.

W. H. STEAVENSON, Esq.

HAROLD THOMSON, Esq., M.Sc.